



**US Army Corps  
of Engineers®**  
Engineer Research and  
Development Center

# **Boston Harbor, Massachusetts, Deep-Draft Navigation Improvement Project Feasibility Study**

Channel Improvement Investigations

Dennis W. Webb and Mark L. Habel

August 2006

# **Boston Harbor, Massachusetts, Deep-Draft Navigation Improvement Project Feasibility Study**

Channel Improvement Investigations

Dennis W. Webb

*Coastal and Hydraulics Laboratory  
U.S. Army Engineer Research and Development Center  
3909 Halls Ferry Road  
Vicksburg, MS 39180-6199*

Mark L. Habel

*U.S. Army Engineer District, New England  
696 Virginia Road  
Concord, MA 01742-2751*

Final report

Approved for public release; distribution is unlimited.

**Abstract:** Boston Harbor is located on the eastern shore of the Commonwealth of Massachusetts, on Massachusetts Bay. The Corps of Engineers and the Massachusetts Port Authority (Massport) are evaluating a number of improvements to Boston Harbor. These improvements include deepening and widening portions of the Broad Sound North Entrance Channel, Main Ship Channel, and lower Reserved Channel and its turning area for the benefit of larger container vessels calling on Massport's Conley Terminal. To assist in evaluating these improvements, the U.S. Army Engineer Research and Development Center (ERDC) conducted a ship-simulator-based navigation study. Data for the simulation models were obtained during a site visit to ride ships in the project area. Currents for both the existing and proposed channels were calculated using the ADCIRC computer model in a joint effort between ERDC and the U.S. Army Engineer District, New England. Harbor pilots traveled from Boston to validate and operate the simulations in September 2005.

**DISCLAIMER:** The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products. All product names and trademarks cited are the property of their respective owners. The findings of this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

**DESTROY THIS REPORT WHEN NO LONGER NEEDED. DO NOT RETURN IT TO THE ORIGINATOR.**

# Contents

<b>Figures .....</b>	<b>v</b>
<b>Preface .....</b>	<b>vi</b>
<b>Unit Conversion Factors .....</b>	<b>vii</b>
<b>1 Introduction .....</b>	<b>1</b>
Background .....	1
Purpose .....	5
<b>2 Proposed Improvements .....</b>	<b>6</b>
Entrance and main channel deepening .....	6
Main Ship Channel deepening extension to Ted Williams Tunnel .....	7
Ted Williams Tunnel to confluence of Mystic and Chelsea Rivers .....	9
Mystic River .....	9
Chelsea River .....	10
<b>3 Reconnaissance Trip .....</b>	<b>11</b>
November 16 .....	11
November 17 .....	13
November 18 .....	14
<b>4 Database Development and Validation .....</b>	<b>16</b>
Database development .....	16
Validation .....	18
<b>5 Tug Usage .....</b>	<b>20</b>
<b>6 Results .....</b>	<b>21</b>
Main Ship Channel improvements and Plan 1 turning notch .....	21
<i>Inbound, flood tide, 30 knots northeast wind, backing into Reserved Channel .....</i>	<i>21</i>
<i>Inbound, flood tide, 30 knots northwest wind, backing into Reserved Channel .....</i>	<i>22</i>
<i>Inbound, ebb tide, 30 knots northeast wind, backing into Reserved Channel .....</i>	<i>22</i>
<i>Inbound, ebb tide, 30 knots northwest wind, backing into Reserved Channel .....</i>	<i>22</i>
<i>Outbound, flood tide, 30 knots northeast wind, backing out of Reserved Channel .....</i>	<i>23</i>
<i>Outbound, flood tide, 30 knots northwest wind, backing out of Reserved Channel .....</i>	<i>23</i>
<i>Outbound, ebb tide, 30 knots northeast wind, backing out of Reserved Channel .....</i>	<i>24</i>
<i>Outbound, ebb tide, 30 knots northwest wind, backing out of Reserved Channel .....</i>	<i>24</i>
<i>Inbound, ebb tide, 30 knots northwest wind, backing out of Reserved Channel .....</i>	<i>24</i>
Plan 2 turning notch .....	25
<i>Inbound, ebb tide, 30 knots northwest wind, backing into Reserved Channel .....</i>	<i>25</i>
<i>Outbound, ebb tide, 30 knots northwest wind, backing out of Reserved Channel .....</i>	<i>25</i>
<i>Outbound, ebb tide, 30 knots northeast wind, backing out of Reserved Channel .....</i>	<i>25</i>

<i>Inbound, flood tide, 30 knots northeast wind, backing into Reserved Channel.....</i>	<i>25</i>
Boston North Channel bend widener.....	26
<i>Inbound, flood tide, 30 knots northeast wind .....</i>	<i>26</i>
<i>Outbound, flood tide, 30 knots northeast wind.....</i>	<i>26</i>
<i>Inbound, flood tide, 30 knots northwest wind.....</i>	<i>26</i>
<i>Outbound, flood tide, 30 knots northwest wind .....</i>	<i>26</i>
Final questionnaire .....	27
<b>7 Recommendations .....</b>	<b>28</b>
<b>References.....</b>	<b>30</b>
<b>Appendix A: Pilot Questionnaires.....</b>	<b>58</b>
<b>Report Documentation Page</b>	

## Figures

Figure 1. Boston Harbor location map. ....	2
Figure 2. Boston Harbor, existing conditions. ....	3
Figure 3. Boston Harbor, proposed conditions. ....	6
Figure 4. Boston North Channel bend widener. ....	8
Figure 5. Widening near Reserve Channel. ....	9
Figure 6. Buoy marking wreck. ....	12
Figure 7. <i>MV MSC Jeanne</i> approaching Reserve Channel. ....	13
Figure 8. Pilot's recommended widening for anchorage. ....	14
Figure 9. <i>MV Delphina</i> passes through Chelsea Street Bridge. ....	14
Figure 10. Boston Ship Pilot turning containership near mouth of Reserve Channel. ....	17
Figure 11. New buoys for bend widener. ....	17
Figure 12. ECDIS display modified to show improved turning notch at mouth of Reserve Channel. ....	18
Figure 13. Plan 2 turning notch. ....	19
Figure 14. Recommended modifications to the Plan 1 turning notch. ....	29

## Preface

The model investigation described herein was conducted for the U.S. Army Engineer District, New England, by the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg MS. The simulator experiments were performed during September 2005 by personnel of the Coastal and Hydraulics Laboratory (CHL).

The New England District was informed of the progress of the simulator study through monthly progress reports. Mark Habel, New England District, was in charge of project oversight for the District. The simulation models for the *Cosco Hamburg* and *Delaware Bridge* were developed by Designers and Planners, Inc.

The principal investigator in immediate charge of the navigation portion of the simulator study was Dennis W. Webb, assisted by Peggy Van Norman, Donna Derrick, Danny Marshall, and Gary Lynch, all of the Navigation Branch, CHL, and Ms. Sally Harrison, contractor for Analytical Services, Inc. Mr. Webb and Mr. Habel prepared this report, under the general supervision of Dr. Margaret Rose Kress, Chief, Navigation Division; Dr. William D. Martin, Deputy Director, CHL; and Mr. Thomas W. Richardson, Director, CHL.

Commander and Executive Director of ERDC was COL Richard B. Jenkins. Director was Dr. James R. Houston.

## Unit Conversion Factors

Multiply	By	To Obtain
feet	0.3048	meters
knots	0.5144444	meters per second



# 1 Introduction

## Background

Boston Harbor is located on the eastern shore of the Commonwealth of Massachusetts, on Massachusetts Bay (Figure 1). The layout of the existing Federal Navigation Project for Boston Harbor is shown in Figure 2. Deeply loaded commercial traffic uses the Broad Sound North Entrance Channel to access the harbor. Use of the other two entrance channels, the 30-ft Broad Sound South Channel and the 27-ft Narrow Channel, is limited to smaller ships and barges, mainly those in transit between the Port and the Cape Cod Canal to the south. Ships that presently call at Boston Harbor include petroleum tankers, bulk product carriers, containerships, and liquefied natural gas (LNG) tankers. The principal dry bulk cargos include salt and cement imports, and scrap and newsprint exports.

The existing Federal Navigation Project for Boston Harbor consists of the three entrance channels described above, a Main Ship Channel connecting the confluence of the three entrance channels off Deer Island with the lower and upper harbor areas, a deep-draft anchorage in President Roads, and several commercial tributary channels (the Reserved Channel, Fort Point Channel, Charles River, lower Mystic River, and Chelsea River).

Prior to 1930 the North Entrance Channel and Main Ship Channel had depths of –35 ft and widths of 1500 and 1200 ft, respectively. From 1930 to the mid-1950s, a 40-ft channel was constructed from the sea to the inner confluence of the Mystic and Chelsea Rivers, but not to the full channel width. In the North Entrance Channel and the lower reaches of the Main Ship Channel, the deeper 40-ft lane was dredged along the south limit of the channel, 900 ft wide in the entrance and 600 ft wide in the lower main ship channel. Above Commonwealth Pier in South Boston, the 40-ft lane shifted to the north side of the Main Ship Channel, and then shifted back to the northwest side above the Charles River. The intent seems to have been to ensure that the 40-ft depth accessed the several U.S. Navy facilities located on both sides of the harbor. The result today is an asymmetrical layout for the deep-draft channels, as shown in Figure 2.



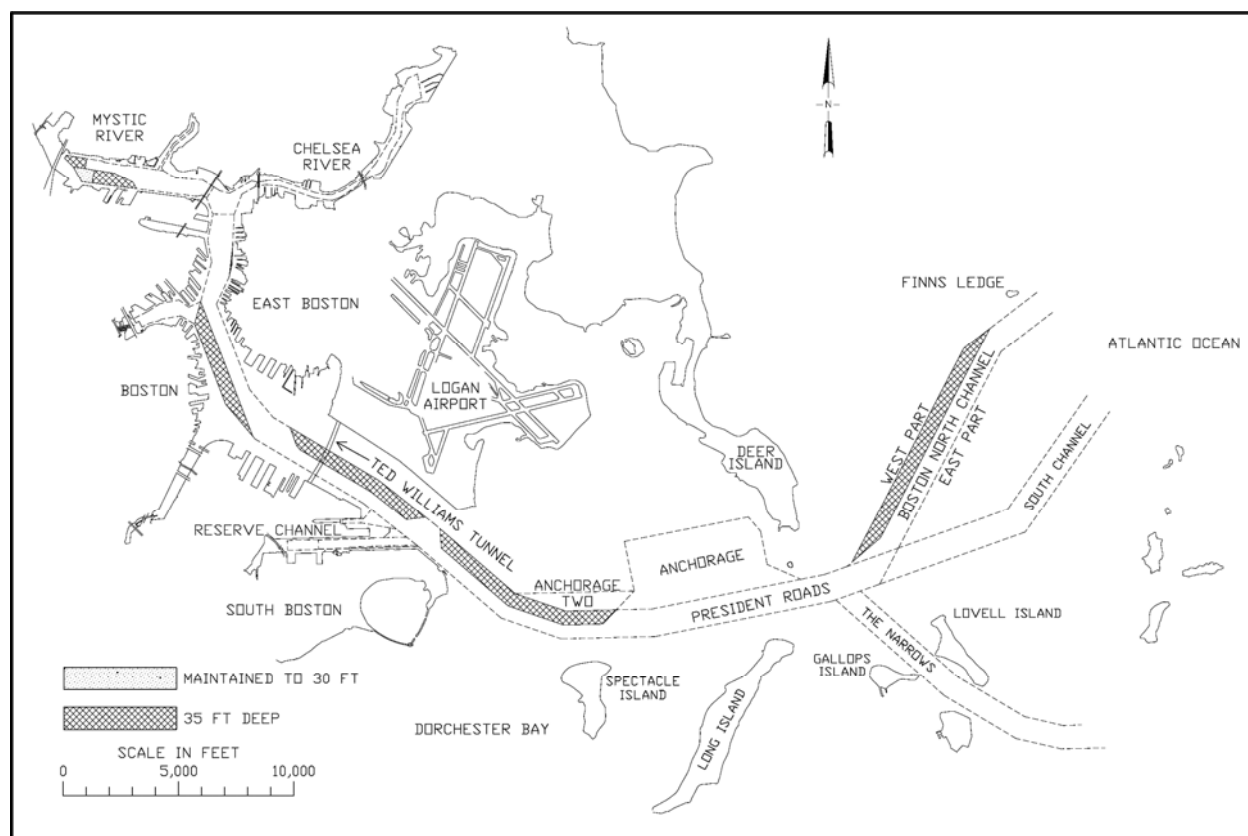


Figure 2. Boston Harbor, existing conditions.

The U.S. Coast Guard marks only the outer limits of the channels, and not the division between the 35- and 40-ft lanes. Consequently, safe navigation of larger vessels relies on the expert knowledge and experience of the harbor pilots and docking masters. Rules of the road regarding the passing of larger vessels rely on local knowledge and communication so that the deeper draft vessel can travel in the 40-ft lane.

The Reserved Channel in South Boston is 40 ft deep in its lower two-thirds along the Conley Terminal on the south shore and the former Army Base, now a dry bulk (cement) terminal on the north shore. Above this area the channel depth is 35 ft to access the upper berths of the Black Falcon Cruise Ship Terminal. The Main Ship Channel, at its confluence with the Reserved Channel, has been deepened to 40 ft for its full 1200-ft width to provide a turning basin for vessels accessing the Reserved Channel.

The 23-ft Fort Point Channel and 35-ft lower Charles River Channel are not included in this study as project dimensions are at least adequate for prospective commerce. The U.S. Coast Guard (USCG) Group Boston is located on the 35-ft Charles River Channel. Smaller visiting U.S. and NATO

warships are berthed at the former Navy Yard on the Charles River Channel. Deeper draft vessels such as carriers are berthed at the World Trade Center on the 40-ft Main Ship Channel during port visits.

The deep-draft reaches of the Mystic River Channel between the Tobin and Malden Bridges are divided into 40-, 35-, and 30-ft areas. Most of the channel was deepened to 40 ft under the project of 1990 between 1998 and 2001. The full width of the lower, eastern end of the channel is at 40 ft to access the Boston Autoport and Exxon Terminals. The northern half of most of the upper length of the channel along the Everett shore is also 40 ft. The remaining areas are authorized to 35 ft, with the far upper end of the channel along the southern (Charlestown) shore only maintained to -30 ft. At the time of the 1990 authorization and 1996 design memorandum, the Massachusetts Port Authority (Massport) plans for its Medford Street Terminal, located immediately upstream of the Boston Autoport along the southern shore, were not far enough advanced to permit a favorable economic justification for deepening this area of the channel to 40 ft.

The Chelsea River Channel, from the inner confluence to the head of navigation in Revere, has an authorized depth of 38 ft under the project of 1990. The 38-ft depth was the limit that could be economically justified with increased vessel drafts and capacities without replacement of the Chelsea Street Bridge. With the exception of a small area near the Chelsea Street Bridge that is awaiting utility relocation, the 38-ft deepening project was completed in 2002. As the USCG and City of Boston are proceeding with plans to replace the bridge, deepening this channel to 40 ft is once again being considered.

The Port's only container facility, the Conley Terminal, is located on the 40-ft lower reach of the Reserved Channel in South Boston. This is the Port's seaward most commercial terminal. The Port's only LNG facility, Distrigas, is located on the north side of the 40-ft Mystic River Channel near its head of deep-draft navigation. The Port's major petroleum terminals are located along the 38-ft Chelsea River Channel, with the sole exception of the Exxon Terminal on the Mystic River, below the Distrigas LNG Terminal. Boston Harbor has a mean tidal range of approximately 10 ft and a spring range of about 13.5 ft.



## **Purpose**

The U. S. Army Engineer District, New England, is presently evaluating channel designs to deepen portions of Boston Harbor and widen some of the turns. The primary purpose of these improvements is to allow larger containerships to call at the docks at the Conley Terminal on the Reserved Channel.

The U. S. Army Engineer Research and Development Center (ERDC) conducted a navigation study utilizing real-time ship simulation modeling to evaluate the proposed improvements to Boston Harbor. Model development and online testing occurred at the ERDC Waterways Experiment Station in Vicksburg, MS, during the period April to September 2005.

## 2 Proposed Improvements

The New England District and Massport are evaluating a number of improvements to Boston Harbor's system of channels and anchorage area. The proposed improvements for Boston Harbor are shown in Figure 3.

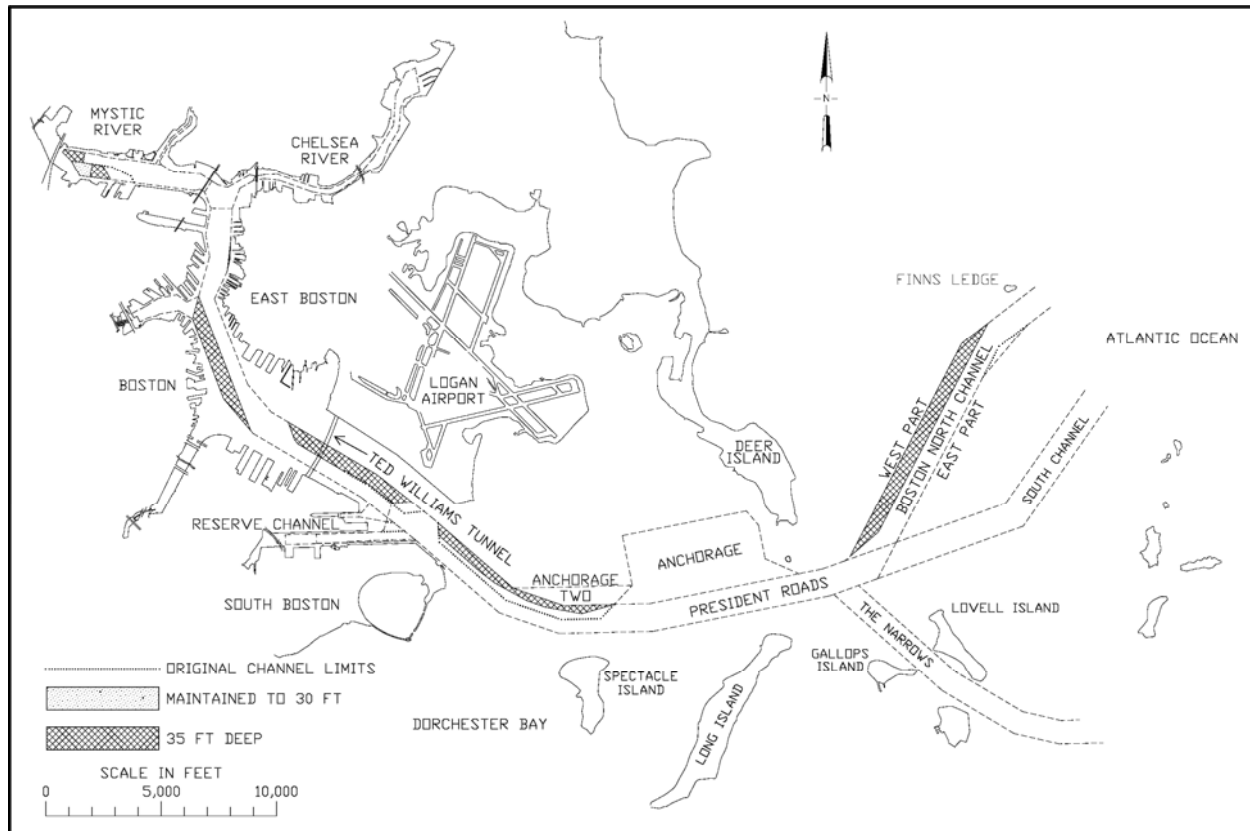


Figure 3. Boston Harbor, proposed conditions.

### Entrance and main channel deepening

The first improvement plan would deepen the Broad Sound North Entrance Channel, Main Ship Channel, and the lower Reserved Channel and its turning area for the benefit of larger container vessels calling on Massport's Conley Terminal. A channel depth of -45 ft mean lower low water (MLLW) in the harbor is being considered, with incremental optimization between 42 and 50 ft. This plan includes (1) deepening the 40-ft lane of the Broad Sound North Entrance Channel from Massachusetts Bay to the outer confluence to a depth of -47 ft MLLW (the additional 2 ft in depth to compensate for increased wave and wind action), (2) deepening the Main

Ship Channel from the outer confluence through President Roads and up-harbor to the Reserved Channel to –45 ft, (3) deepening the 40-ft lower reach of the Reserved Channel to 45 ft, (4) deepening the Reserved Channel turning area to 45 ft and expanding it northwesterly up the main channel to accommodate larger vessels, and (5) deepening all or a portion of the President Roads Anchorage to 45 ft.

The deepened entrance channel will retain its 1100-ft entrance reach width and its 900-ft width in its remaining length. The current 35-ft-deep lane would remain unchanged. A bend widener is proposed at the turn where the 1100- and 900-ft-wide reaches join in response to pilots' concerns to have additional maneuvering width opposite Finns Ledge. A closeup of the widener is shown in Figure 4.

The portion of the Main Ship Channel along the south side of President Roads would retain its current 1200-ft width to facilitate safe access and egress from the anchorage and permit recovery of vessel course before entering the turns at Spectacle Island. The deepened channel would be widened to 800 ft by incorporating portions of the existing 35-ft lane. In the turns at Spectacle Island the channel would be widened further to 880 ft to increase the width available for vessel maneuvering through the turns, easing a difficult bend, especially for the larger containerships that are expected to call at Reserved Channel. The transition from the anchorage and the 1200-foot channel width in President Roads into the narrower lower Main Ship Channel would also be flared into the 35-ft lane to ease the approach up-harbor. These improvements are shown in Figure 5.

### **Main Ship Channel deepening extension to Ted Williams Tunnel**

In order to accommodate plans by Massport to develop a new dry bulk terminal at the Massport Marine Terminal in South Boston, extending the proposed deepening of the Main Ship Channel above the Reserved Channel to below the Ted Williams Tunnel is also being considered. Massport's plans for this facility include leases for the receipt or export of cement, aggregates, newsprint, steel, and other bulk products. The clearances over the Ted Williams Tunnel above this terminal limit channel depths in the upper harbor areas to the 40 ft already provided. The reach of the Main Ship Channel to be deepened to 45 ft under this plan would be widened to 650 ft by including a 50-ft-wide strip of the current 35-ft lane.

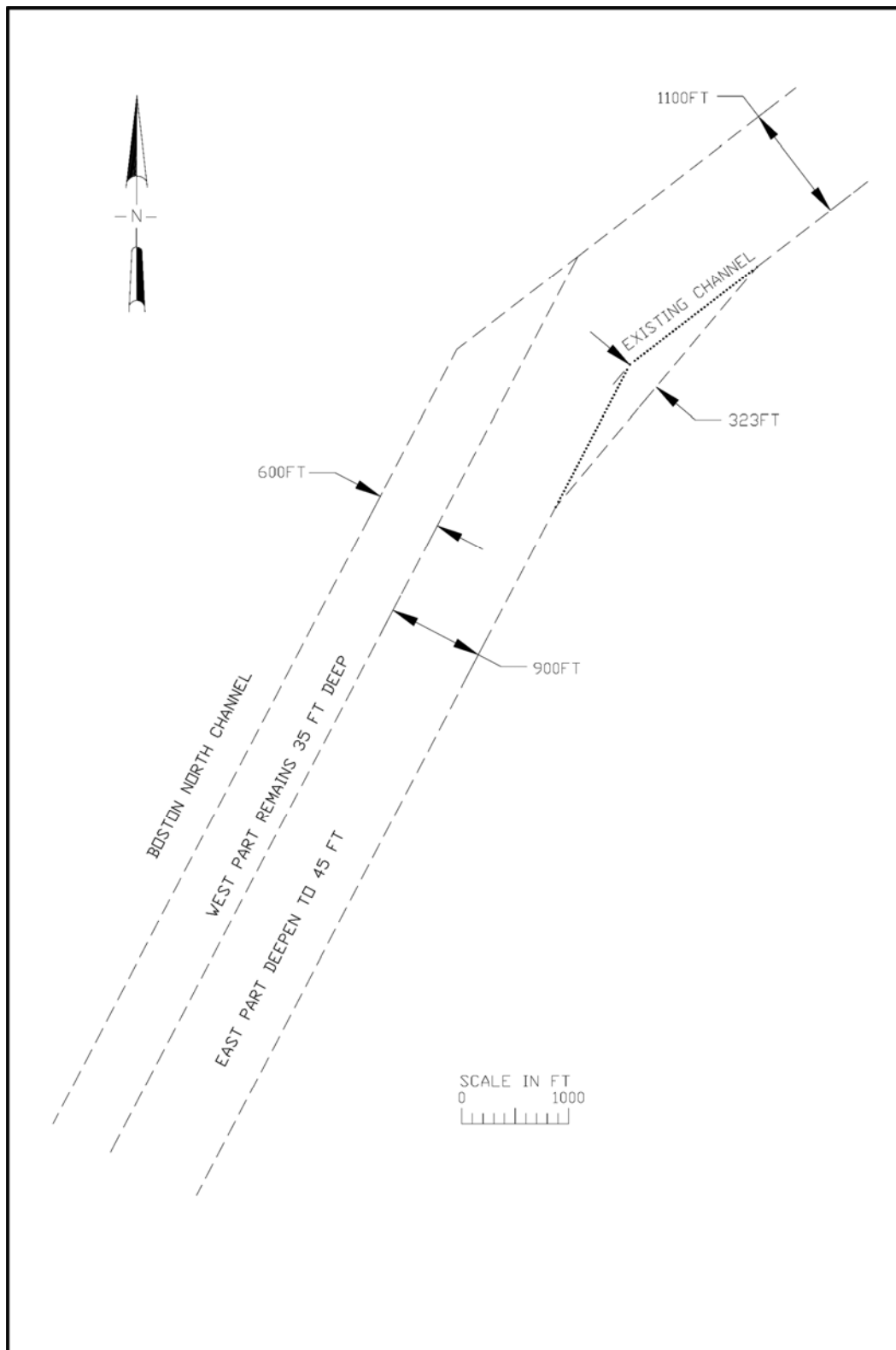


Figure 4. Boston North Channel bend widener.



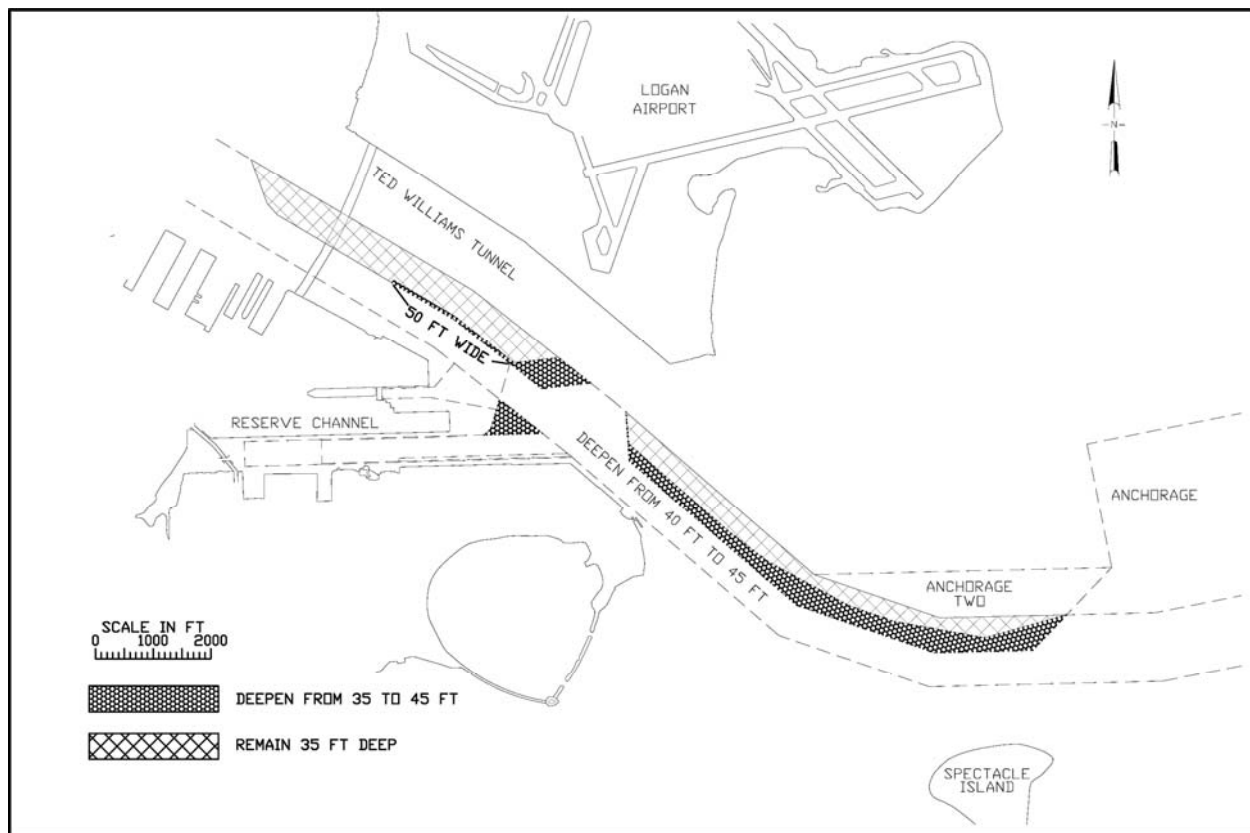


Figure 5. Widening near Reserve Channel.

## Ted Williams Tunnel to confluence of Mystic and Chelsea Rivers

No channel improvements are proposed for this section of the harbor, including the Fort Point and Charles River Channel tributaries.

## Mystic River

A portion of the existing 35-ft channel will be deepened to 40 ft to permit deeper access to Massport's Medford Street Terminal for bulk cargo vessels. This is shown in Figure 3. This area is located about midway along the southern half of the Mystic Channel above the Boston Autoport. This area was not included in the 1990 project authorization, as plans for this terminal had not yet progressed to the point of decisions on its future use. Massport plans to develop the property as another dry bulk terminal and has already deepened the berths to -40 ft. This will allow large bulk carriers to call without having to wait for tidal advantage. Since there will be no increase in ship size over those now plying this waterway, and currents are negligible throughout the tidal cycle, this improvement did not require being included in this navigation study.

## Chelsea River

The Chelsea River is being considered for deepening from 38 ft to 40 ft. The 1990 project only recommended a 38-ft depth for this waterway because the Chelsea Street Bridge limited design vessel dimensions, particularly beam, so greater improvements were impractical with bridge replacement. With the USCG and the City of Boston now pursuing funds for a new bridge, a 40-ft improvement is being reconsidered. This area was included in the 1992 ship simulation study that examined vessels of the classes that would be expected to use the waterway under the 38-ft improvement and also considered a 40-ft improvement without the bridge. That study showed that larger tank ships that would require the 40-ft depth would also require bridge replacement and bend easing. Therefore, Chelsea River is not included in this navigation study.

### 3 Reconnaissance Trip

The reconnaissance trip for the Boston Harbor study was conducted November 15-19, 2004. The purpose of the trip was to meet with New England District representatives and the Boston Pilots. These meetings primarily took place upon ships transiting the study area so navigation practices could be observed. In addition, ERDC representatives took photographs and video, which was later used for simulation model development. ERDC was represented by Dennis Webb and Peggy Van Norman who traveled to Boston on November 15. Upon arrival in Boston, they contacted Capt. Gregg Farmer of the Boston Pilots and Mr. John Winkelman of the New England District to coordinate.

#### November 16

Capt. Farmer, Mr. Webb, Ms. Van Norman, and Mr. Winkelman boarded the *MV Allegiance* in the Atlantic Ocean. The *MV Allegiance* is a 612-ft-long Length-Over-All (LOA) tanker with a beam of 90 ft. The *MV Allegiance* was loaded to a draft of 34 ft and was heading inbound to the Global Terminal on Chelsea Creek. During the transit, Capt. Farmer listed several navigation concerns of the existing and future Boston Harbor:

- A wrecked barge was discovered a few years ago. The wreck was marked by a can buoy (Figure 6) and avoided by the pilots. This obstruction has since been removed by New England District under the last contract for maintenance dredging of the outer harbor channels in 2005. Therefore, this is no longer a concern.
- Swell is a serious issue for the approach channels to Boston Harbor. The channels are operational in up to 18-ft swells with tidal assistance.
- Boston Harbor presently has two asymmetric channels, i.e., two lanes of different depths. Capt. Farmer expressed concern that as the one lane was deepened to 50 ft, they would have problems with bank effects caused by the 35-ft lane.
- Flood currents into Dorchester Bay cause the ship to be set to the green buoys in the turns above Spectacle Island.
- There is also a ledge in this area where the channel is not 40 ft MLLW. This ledge is scheduled for removal to at least -42 ft as part of the upcoming inner harbor maintenance operation.



Figure 6. Buoy marking wreck.

Corps employees disembarked the ship onto the pilot boat in downtown Boston. The *MV Allegiance* and Capt. Farmer continued on to the Global Terminal. Corps representatives disembarked early, at Capt. Farmer's recommendation, so they could ride an inbound containership.

The Corps representatives boarded the *MV MSC Jeanne* in the Atlantic Ocean. The pilot was Capt. Frank Morten. The *MV MSC Jeanne* is a 767-ft-long (LOA) containership with a beam of 106 ft. The inbound draft was 41 ft. The *MV MSC Jeanne* was inbound to the container docks on the Reserved Channel. Capt. Morten reiterated Capt. Farmer's concerns about navigation in Boston Harbor. Figure 7 shows the *MV MSC Jeanne* turning into the Reserved Channel.

The Corps representatives boarded the *MV Zephyros* in the President Roads Anchorage. The *MV Zephyros* is a 538-ft-long (LOA) scrap metal ship with a beam of 75 ft. The *MV Zephyros* was loaded to a draft of 25 ft and was inbound to the Prolerized scrap metal dock on the Mystic River. The pilot for this movement was Capt. Richard Stover.

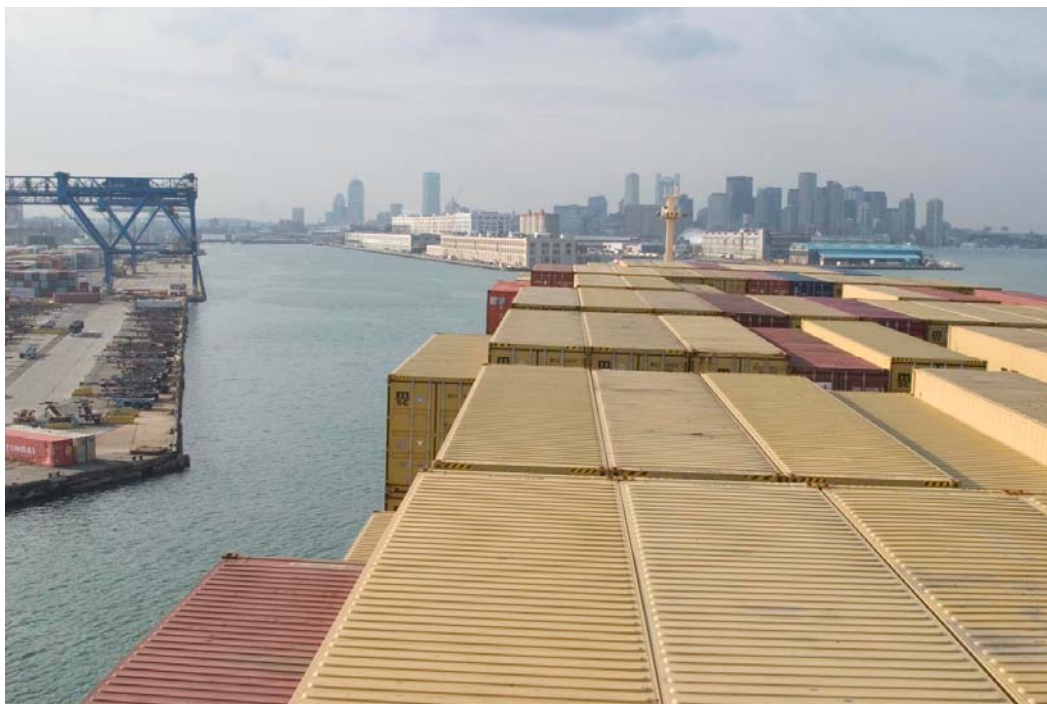
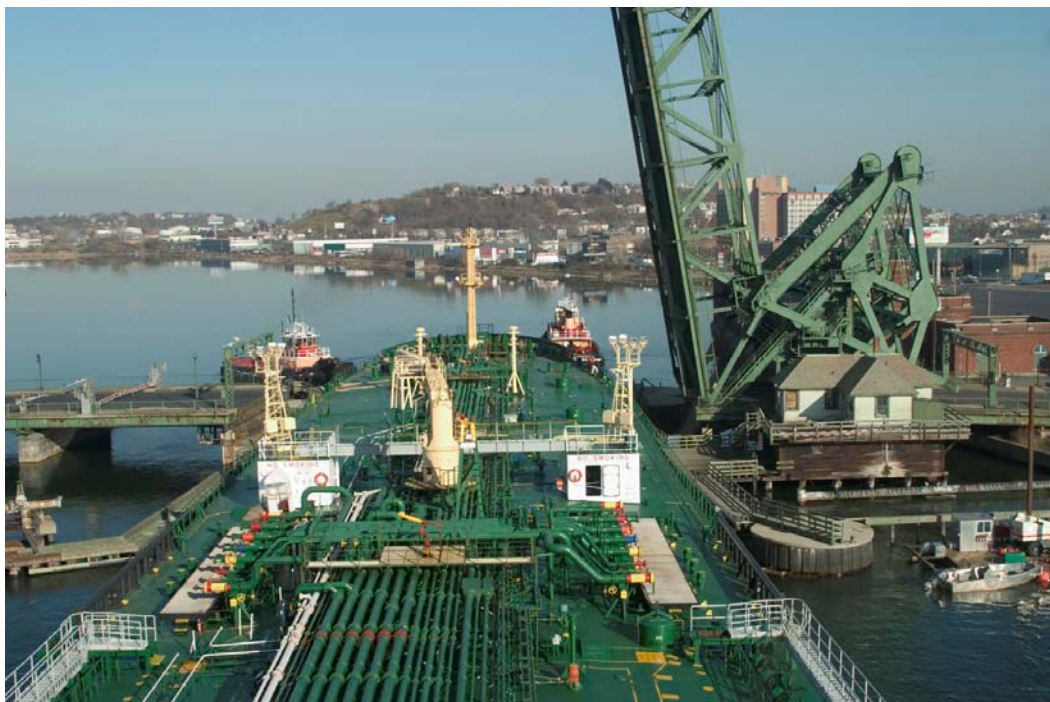
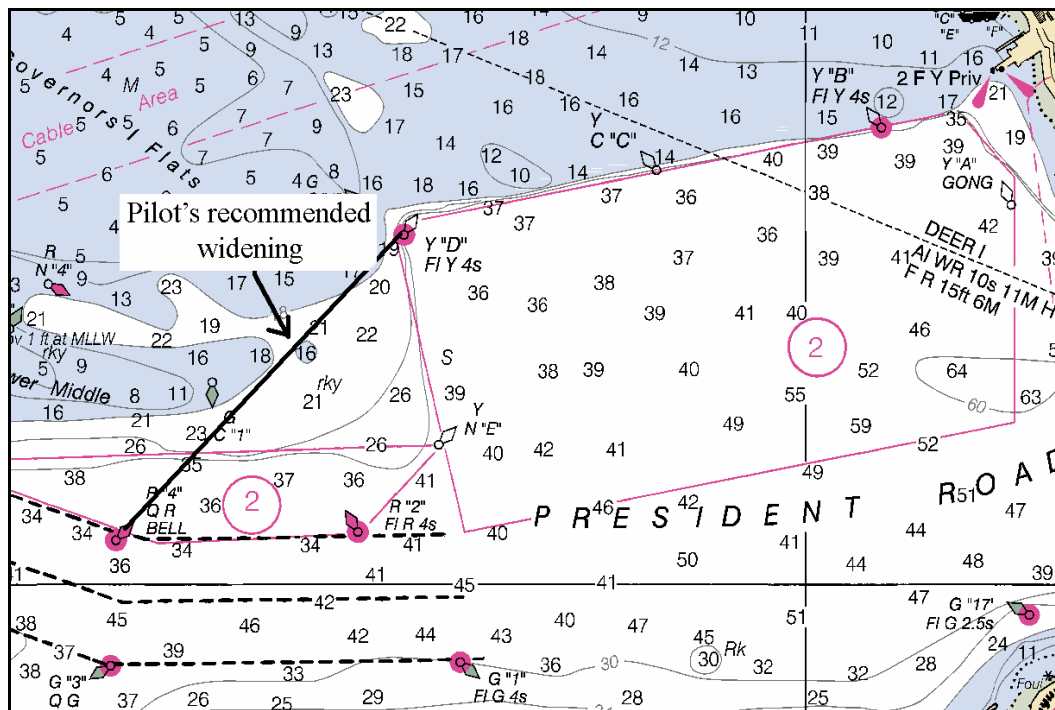


Figure 7. *MV MSC Jeanne* approaching Reserve Channel.

## November 17

Mr. Webb and Ms. Van Norman boarded the *MV Delphina*, Capt. Marty McCabe, pilot. During the ride on the pilot boat, Captains McCabe and Chris Hoyt discussed their desired modifications to the President Roads Anchorage (USCG Anchorage #2). They stated that the anchorage was often crowded with three ships and that flood currents pushed the ships toward the northern end of the anchorage. Both pilots felt that angling the western end of the anchorage to incorporate portions of the 35-ft barge anchorage and areas between the two would make it more effective. The pilots' proposed angle is shown in Figure 8.

The *MV Delphina* is a 610-ft-long (LOA) tanker with a beam of 90 ft. The *MV Delphina* was loaded to a draft of 36 ft. During the transit to the Gulf Oil Dock, the 90-ft-wide *MV Delphina* passed through the 93-ft-wide Chelsea Street Bridge (Figure 9). Corps representatives rode back to the pilot station on a tractor tug, which gave them the opportunity to photograph Chelsea Creek from an outbound viewpoint.

**November 18**

Mr. Webb and Ms. Van Norman boarded the *MV Hoegh Galleon*, Capt. Gregg Farmer, pilot. The *MV Hoegh Galleon* is an 818-ft-long (LOA) LNG

ship with a beam of 131 ft. The ship's draft was approximately 33 ft. The *MV Hoegh Galleon* docked at the Distrigas LNG terminal on the Mystic River, which concluded the reconnaissance trip.

## 4 Database Development and Validation

### Database development

Currents for both the existing and proposed channels were calculated using the ADCIRC model in a joint New England District/ERDC effort (Wilkelman et al., in preparation). Current data for the maximum strength of both the ebb and flood tides were extracted and converted into the format required by the ERDC Ship/Tow Simulator.

Two ship models were developed for the Boston Harbor Navigation Study by Designers & Planners, Inc. (Ankudinov 2005):

- Ship 1. The *COSCO Hamburg*, a 918-ft-long (LOA), 5,618-TEU (TEU = twenty-foot equivalent unit) containership. The ship's beam is 131.2 ft, and the ship is fully loaded to a draft of 45.9 ft.
- Ship 2. The *Delaware Bridge*, a 871.8-ft-long (LOA), 4,713-TEU containership. The ship's beam is 105.6 ft, and the ship is fully loaded to a draft of 43.3 ft.

Both containership models were equipped with bow thrusters.

The visual scene was modified using the photos taken during the reconnaissance trip. Figure 10 shows the visual scene as one of the Boston Pilots operates the simulator. The only adjustment required to the visual scene for the proposed alternative channels was new aids to navigation (ATONS) for the Boston North Channel Bend widener. The buoy marking the wreck was removed, as was buoy G "3". The two new buoys that marked the ends of the widener are shown in Figure 11. The wrecked barge was removed from the approach to Boston Harbor during maintenance dredging during the spring/summer of 2005.

The Electronic Chart Display and Information System (ECDIS) was modified to reflect proposed changes to the channel footprints. Figure 12 shows an ECDIS chart modified to reflect changes at the mouth of the Reserved Channel. It should be noted that the ECDIS editing software does not allow removal of ATONS or modifying contour lines. However, the pilots felt the display showing the proposed channel was adequate.





Figure 10. Boston Ship Pilot turning containership near mouth of Reserve Channel.

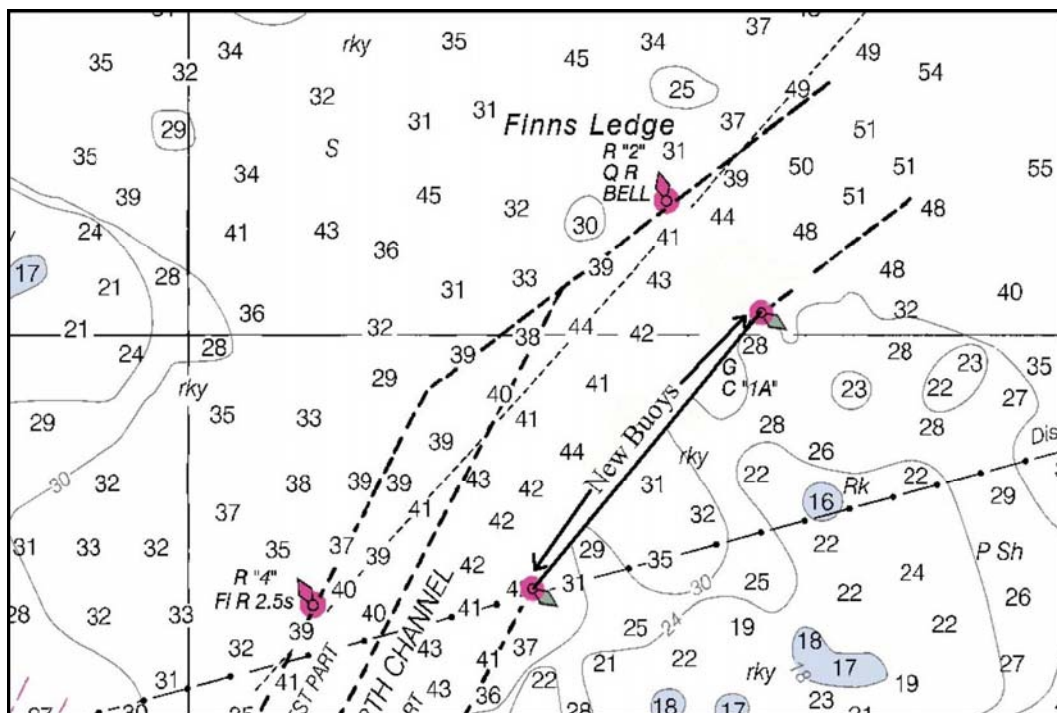


Figure 11. New buoys for bend widener.



Figure 12. ECDIS display modified to show improved turning notch at mouth of Reserve Channel.

## Validation

Validation for Boston Harbor was conducted September 6-9, 2005. Two Boston Harbor Pilots participated in the validation effort. A Massport representative also attended. Validation originally scheduled for August 29 – September 2, 2005, was delayed a week due to Hurricane Katrina. Representatives for New England District were scheduled to attend the original validation week but were unable to reschedule.

During validation, the Massport representative voiced concerns over the location of the improved turning notch. He stated that the improvements were directly in line with the low approach runway for Logan Airport. Representatives from New England District, New York District, ERDC, Massport, and the pilots worked together to formulate an alternative turning area configuration. This turning area, Plan 2, is shown in Figure 13. The ADCIRC model was modified to reflect the channel geometry of Plan 2 and currents were calculated. Simulations of the Plan 2 channel were conducted in the final days of the formal testing program.

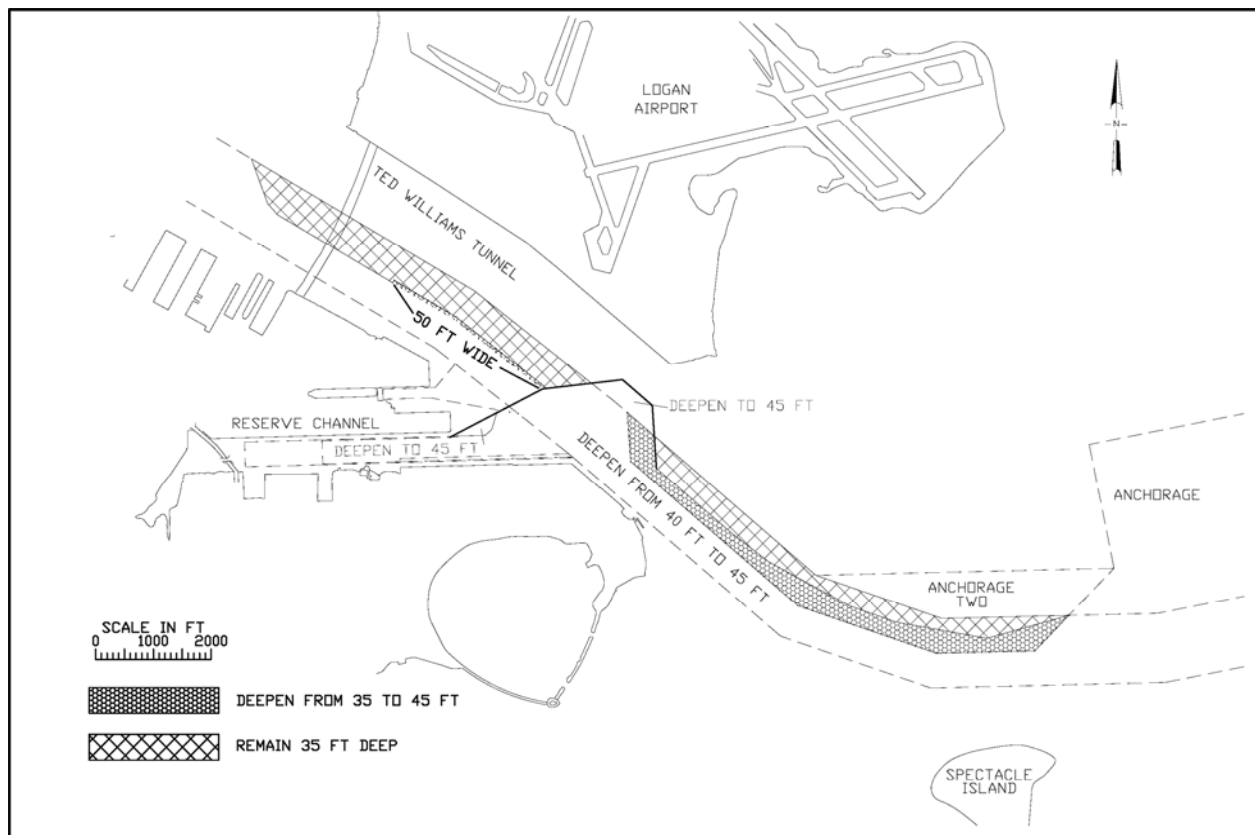


Figure 13. Plan 2 turning notch.

## 5 Tug Usage

Both containerships were equipped with bow thrusters for the simulations. All but one of the runs were completed with two tractor tugs. That one run used two tractor tugs and one conventional tug.

Tractor tugs are a generation beyond normal harbor tugs. Utilizing propulsion such as the Z Drive, the tractor tug can push or pull with little to no loss of thrust efficiency, eliminating most of the need to change position during the job.

Tug usage in the simulator is accomplished by radio communication between the pilot and the simulator operator. Different pilots use the tugs differently, but for the Boston transits, full ahead and astern commands were common. These commands are not unusual and do not necessarily indicate that changes need to be made.

During inbound runs, as the containerships came through Dorchester Bay (20-30 min before getting to Conley Terminal) the pilot would call the tugs alongside. From this point on the tugs were hooked up in order to be in position to work when needed. This position was typically one tug each on the ship's port bow and stern. Once the vessel started its turn for the backing maneuver into Reserve Channel, the tugs worked almost continuously until the transit and initial docking maneuvers were completed. Tug usage during the inbound runs was about 20–25 min (remembering that the transit stopped before the vessel was fully docked). For outbound runs, usage time increased closer to 40 min since the containerships were maneuvering off the terminal face to enter the federal channel.

## 6 Results

Testing was conducted September 12–16 and 17–21, 2005. Four Boston Harbor Pilots participated in the testing program. Simulations of the Plan 2 turning notch were conducted only during the last 3 days of the second session. After each test, the pilot was given a chance to provide written comment on the simulation. At the end of each week of testing, the pilots were given a final questionnaire to complete. These questionnaires are included in Appendix A.

Results are presented in the form of composite track plots. Results will be presented first for the Main Ship Channel and Reserved Channel turning notch improvements. These will be followed by the results for the Boston North Channel bend widener.

### Main Ship Channel improvements and Plan 1 turning notch

#### **Inbound, flood tide, 30 knots northeast wind, backing into Reserved Channel**

Results of the *COSCO Hamburg* inbound through the Main Ship Channel and backing into the Reserved Channel with flood tide and 30 knots of wind from the northeast are shown in Plate 1. Four pilots completed this exercise, with one leaving the northeast end of the turning notch by nearly 260 ft. The other three pilots were able to turn within the notch. Several of the runs left the northeast end of the Reserved Channel. All ships successfully transited the improved Main Ship Channel. One of the four pilots used three tugs to back into the Reserved Channel. The pilot that used three tugs was one of the successful runs.

Results of the *Delaware Bridge* inbound through the Main Ship Channel and backing into the Reserved Channel with flood tide and 30 knots of wind from the northeast are shown in Plate 2. Four pilots completed this scenario. All ships successfully transited the improved Main Ship Channel and successfully turned in the improved notch. One of the runs left the northeast end of the Reserved Channel.

**Inbound, flood tide, 30 knots northwest wind, backing into Reserved Channel**

Results of the *COSCO Hamburg* inbound through the Main Ship Channel and backing into the Reserved Channel with flood tide and 30 knots of wind from the northwest are shown in Plate 3. Four pilots completed this scenario. All ships successfully transited the improved Main Ship Channel and successfully turned in the improved notch. One of the runs left the northeast end of the Reserved Channel.

Results of the *Delaware Bridge* inbound through the Main Ship Channel and backing into the Reserved Channel with flood tide and 30 knots of wind from the northwest are shown in Plate 4. Four pilots completed this scenario. All ships successfully transited the improved Main Ship Channel and successfully turned in the improved notch.

**Inbound, ebb tide, 30 knots northeast wind, backing into Reserved Channel**

Results of the *COSCO Hamburg* inbound through the Main Ship Channel and backing into the Reserved Channel with ebb tide and 30 knots of wind from the northeast are shown in Plate 5. Four pilots tested this scenario. One pilot was unable to stop his ship in time to turn in the notch and could not complete the maneuver. Another ship left the northeast side of the turning notch by nearly 260 ft. A third vessel just crossed the channel limits on the north end of the notch. All ships successfully transited the improved Main Ship Channel.

Results of the *Delaware Bridge* inbound through the Main Ship Channel and backing into the Reserved Channel with ebb tide and 30 knots of wind from the northeast are shown in Plate 6. Four pilots completed this scenario. All ships successfully transited the improved Main Ship Channel. One ship left the turning notch by slightly more than 10 ft.

**Inbound, ebb tide, 30 knots northwest wind, backing into Reserved Channel**

Results of the *COSCO Hamburg* inbound through the Main Ship Channel and backing into the Reserved Channel with ebb tide and 30 knots of wind from the northwest are shown in Plate 7. Four pilots completed this scenario. All ships successfully transited the improved Main Ship Channel.

Two ships left the northeast side of the turning notch, one by approximately 80 ft and the other by approximately 15 ft.

Results of the *Delaware Bridge* inbound through the Main Ship Channel and backing into the Reserved Channel with ebb tide and 30 knots of wind from the northwest are shown in Plate 8. Two pilots successfully completed this scenario. Pilots for the second week of testing did not attempt this exercise in order to complete some scenarios for the Plan 2 notch.

**Outbound, flood tide, 30 knots northeast wind, backing out of Reserved Channel**

Results of the *COSCO Hamburg* backing out of the Reserved Channel and heading outbound through the Main Ship Channel with flood tide and 30 knots of wind from the northeast are shown in Plate 9. Four pilots completed this exercise. All successfully turned in the improved notch. One ship did leave the southern edge of the improved Main Ship Channel by approximately 75 ft.

Results of the *Delaware Bridge* backing out of the Reserved Channel and heading outbound through the Main Ship Channel with flood tide and 30 knots of wind from the northeast are shown in Plate 10. Four pilots completed this exercise. All successfully turned in the improved notch. One ship did leave the southern edge of the improved Main Ship Channel by approximately 75 ft. The same pilot that left the southern edge of the improved Main Ship Channel with the *COSCO Hamburg* also left the channel with the *Delaware Bridge*, by approximately 60 ft.

**Outbound, flood tide, 30 knots northwest wind, backing out of Reserved Channel**

Results of the *COSCO Hamburg* backing out of the Reserved Channel and heading outbound through the Main Ship Channel with flood tide and 30 knots of wind from the northwest are shown in Plate 11. Four pilots completed this exercise. All successfully turned in the improved notch. One ship left the northeast corner of the Reserved Channel by about 15 ft.

Results of the *Delaware Bridge* backing out of the Reserved Channel and heading outbound through the Main Ship Channel with flood tide and 30 knots of wind from the northeast are shown in Plate 12. Four pilots successfully completed this exercise.

**Outbound, ebb tide, 30 knots northeast wind, backing out of Reserved Channel**

Results of the *COSCO Hamburg* backing out of the Reserved Channel and heading outbound through the Main Ship Channel with ebb tide and 30 knots of wind from the northeast are shown in Plate 13. Four pilots completed this exercise. One ship crossed the northeast end of the Reserved Channel while backing into the notch. All ships turned in the improved notch and transited the improved Main Ship Channel successfully.

Results of the *Delaware Bridge* backing out of the Reserved Channel and heading outbound through the Main Ship Channel with ebb tide and 30 knots of wind from the northeast are shown in Plate 14. Four pilots completed this exercise. One ship crossed the northeast end of the Reserved Channel while backing into the notch. All ships turned in the improved notch and transited the improved Main Ship Channel successfully.

**Outbound, ebb tide, 30 knots northwest wind, backing out of Reserved Channel**

Results of the *COSCO Hamburg* backing out of the Reserved Channel and heading outbound through the Main Ship Channel with ebb tide and 30 knots of wind from the northwest are shown in Plate 15. Two pilots completed this exercise. Both ships turned in the improved notch and transited the improved Main Ship Channel successfully.

Results of the *Delaware Bridge* backing out of the Reserved Channel and heading outbound through the Main Ship Channel with ebb tide and 30 knots of wind from the northwest are shown in Plate 16. Two pilots completed this exercise. One ship crossed the northeast end of the Reserved Channel while backing into the notch. Both ships turned in the improved notch and transited the improved Main Ship Channel successfully.

**Inbound, ebb tide, 30 knots northwest wind, backing out of Reserved Channel**

At a pilot's request, a scenario of a ship turning bow-in to Reserved Channel was undertaken. The scenario included a ship docked at the outer berth. Results of this exercise with the *COSCO Hamburg* are shown in Plate 17. Only one pilot completed this exercise. The ship entered the 35-ft-deep portion of the Main Ship Channel by about 20 ft while swinging



his ship to port. The pilot used two tugs and felt that three would be required in real life.

## **Plan 2 turning notch**

### **Inbound, ebb tide, 30 knots northwest wind, backing into Reserved Channel**

Results of the *COSCO Hamburg* inbound through the Main Ship Channel and backing into the Reserved Channel, using the Plan 2 turning notch, with ebb tide and 30 knots of wind from the northwest are shown in Plate 18. Two pilots completed this scenario. However, both pilots did a repeat run on the scenario. One pilot left the north side of the notch by about 170 ft on his first attempt. The other three runs were successful.

### **Outbound, ebb tide, 30 knots northwest wind, backing out of Reserved Channel**

Results of the *COSCO Hamburg* backing out of the Reserved Channel, turning in the Plan 2 turning notch, and heading outbound through the Main Ship Channel with ebb tide and 30 knots of wind from the northwest are shown in Plate 19. Only one pilot attempted this exercise. It was successfully completed.

### **Outbound, ebb tide, 30 knots northeast wind, backing out of Reserved Channel**

Results of the *COSCO Hamburg* backing out of the Reserved Channel, turning in the Plan 2 turning notch, and heading outbound through the Main Ship Channel with ebb tide and 30 knots of wind from the northeast are shown in Plate 20. Two pilots attempted this exercise, both successfully.

### **Inbound, flood tide, 30 knots northeast wind, backing into Reserved Channel**

Results of the *COSCO Hamburg* inbound through the Main Ship Channel and backing into the Reserved Channel, using the Plan 2 turning notch, with flood tide and 30 knots of wind from the northeast are shown in Plate 21. Two pilots completed this scenario. However, one pilot brought his ship approximately 100 ft out of the north side of the Plan 2 turning notch. Both ships left the northeast end of the Reserved Channel.

## **Boston North Channel bend widener**

### **Inbound, flood tide, 30 knots northeast wind**

Results of the *COSCO Hamburg* inbound through the Boston North Channel bend widener with flood tide and 30 knots of wind from the northeast are shown in Plate 22. Four pilots completed this exercise, all successfully using the bend widener.

Results of the *Delaware Bridge* inbound through the Boston North Channel bend widener with flood tide and 30 knots of wind from the northeast are shown in Plate 23. Four pilots completed this exercise, all successfully using the bend widener.

### **Outbound, flood tide, 30 knots northeast wind**

Results of the *COSCO Hamburg* outbound through the Boston North Channel bend widener with flood tide and 30 knots of wind from the northeast are shown in Plate 24. Four pilots completed this exercise, all successfully using the bend widener.

Results of the *Delaware Bridge* outbound through the Boston North Channel bend widener with flood tide and 30 knots of wind from the northeast are shown in Plate 25. Four pilots completed this exercise, all successfully using the bend widener.

### **Inbound, flood tide, 30 knots northwest wind**

Results of the *COSCO Hamburg* inbound through the Boston North Channel bend widener with flood tide and 30 knots of wind from the northwest are shown in Plate 26. Two pilots completed this exercise, both successfully using the bend widener.

### **Outbound, flood tide, 30 knots northwest wind**

Results of the *COSCO Hamburg* outbound through the Boston North Channel bend widener with flood tide and 30 knots of wind from the northwest are shown in Plate 27. Two pilots completed this exercise, both successfully using the bend widener.

## **Final questionnaire**

At the end of their simulator testing session, the pilots completed a final questionnaire (included as Appendix A). In the questionnaire, the pilots stated their support for the improvements to the both Plans 1 and 2 turning notches, the Main Ship Channel, and the bend widener for the Boston North Channel. The two pilots that had the opportunity to simulate the Plan 2 turning notch felt it was adequate and even superior to the Plan 1 notch.

## 7 Recommendations

Based upon the simulator results and the pilot's final questionnaires, the following recommendations are made for the Boston Harbor Channel improvements:

- a.* The Boston North Channel bend widener is recommended without any modifications.
- b.* The widening of the Main Ship Channel is recommended without any modifications.
- c.* The Plan 1 turning notch is recommended with the modifications shown in Figure 14. A number of ships left the northeastern edge of the turning notch. This edge should be extended 100 ft. A number of ships also left the northeast end of the Reserved Channel. Modifying the Plan 1 notch to resemble the Plan 2 notch in this area is recommended.
- d.* The Plan 2 turning notch is recommended without any modifications. Only two pilots were able to test the Plan 2 notch, and they felt the notch was adequate. It is recommended that two additional pilots participate in a 2- or 3-day simulation program to verify these results. The modified Plan 1 turning notch could also be simulated at this time. However, this is not a requirement.

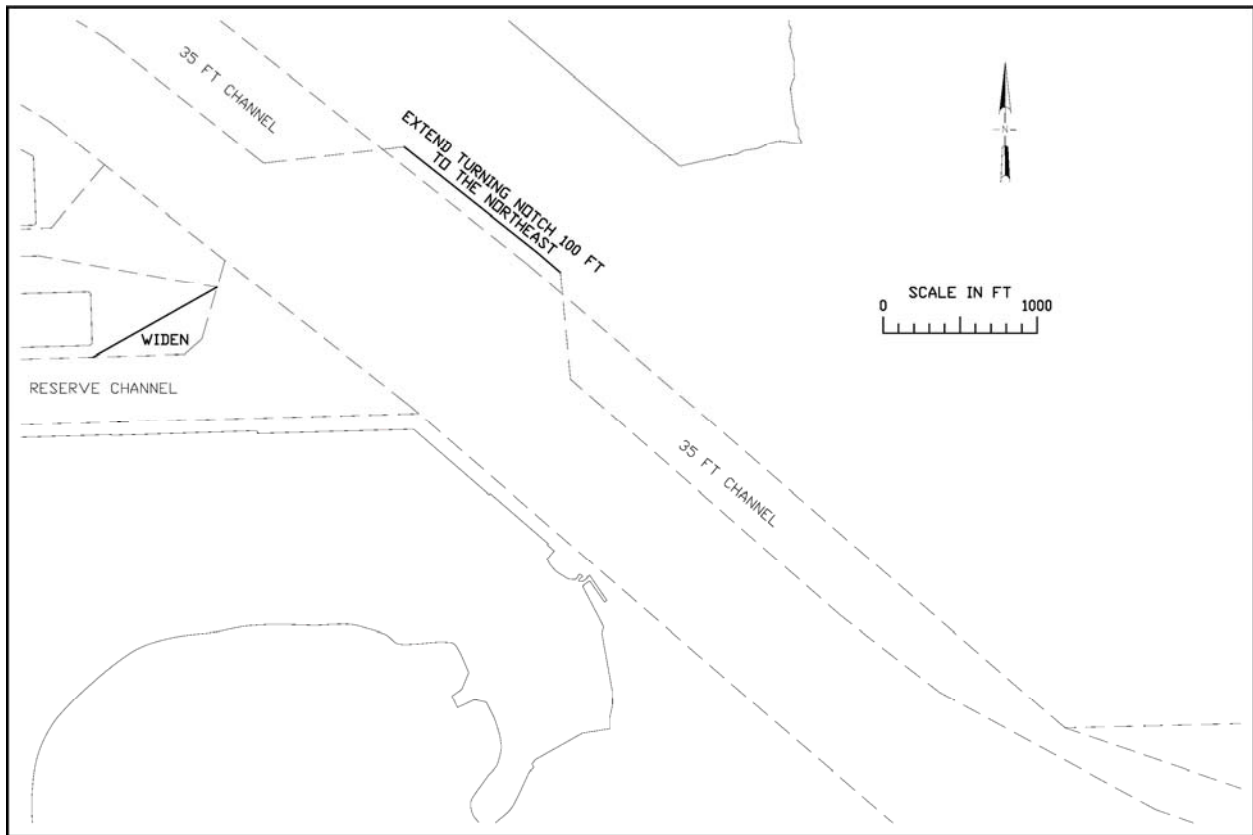


Figure 14. Recommended modifications to the Plan 1 turning notch.

## References

Ankudinov, V. 2005. Development of two hi-fidelity ship models for a ship simulation study of Boston Harbor: “*COSCO Hamburg*”, and “*Delaware Bridge*.” Arlington, VA: BTM Designers & Planners, Inc.

Wilkelman, J., Z. Demirbilek, and L. Lin. *Boston Harbor Deep Draft Navigation Channel Improvement: 2-D Hydraulic Modeling*. In preparation.

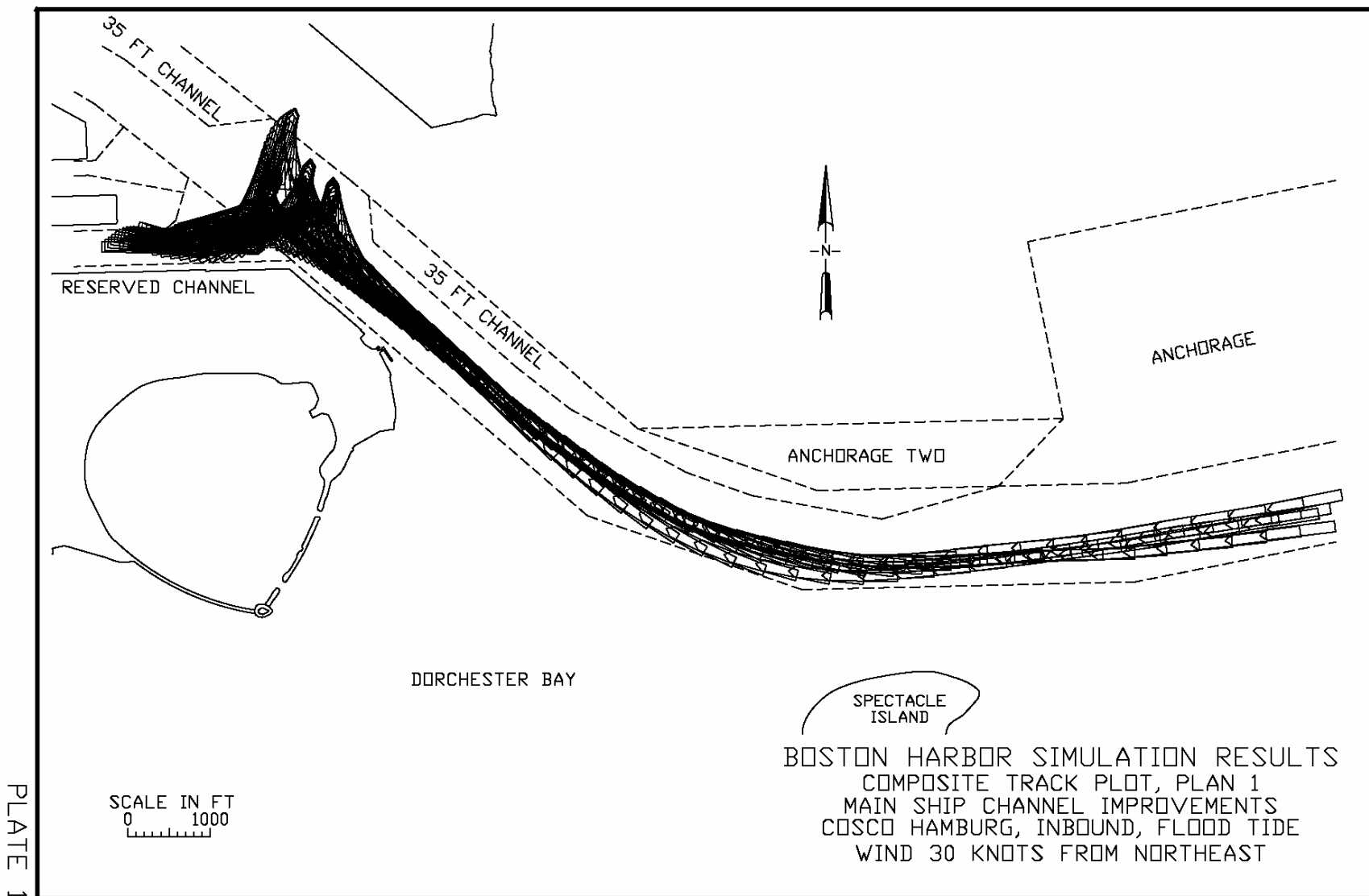
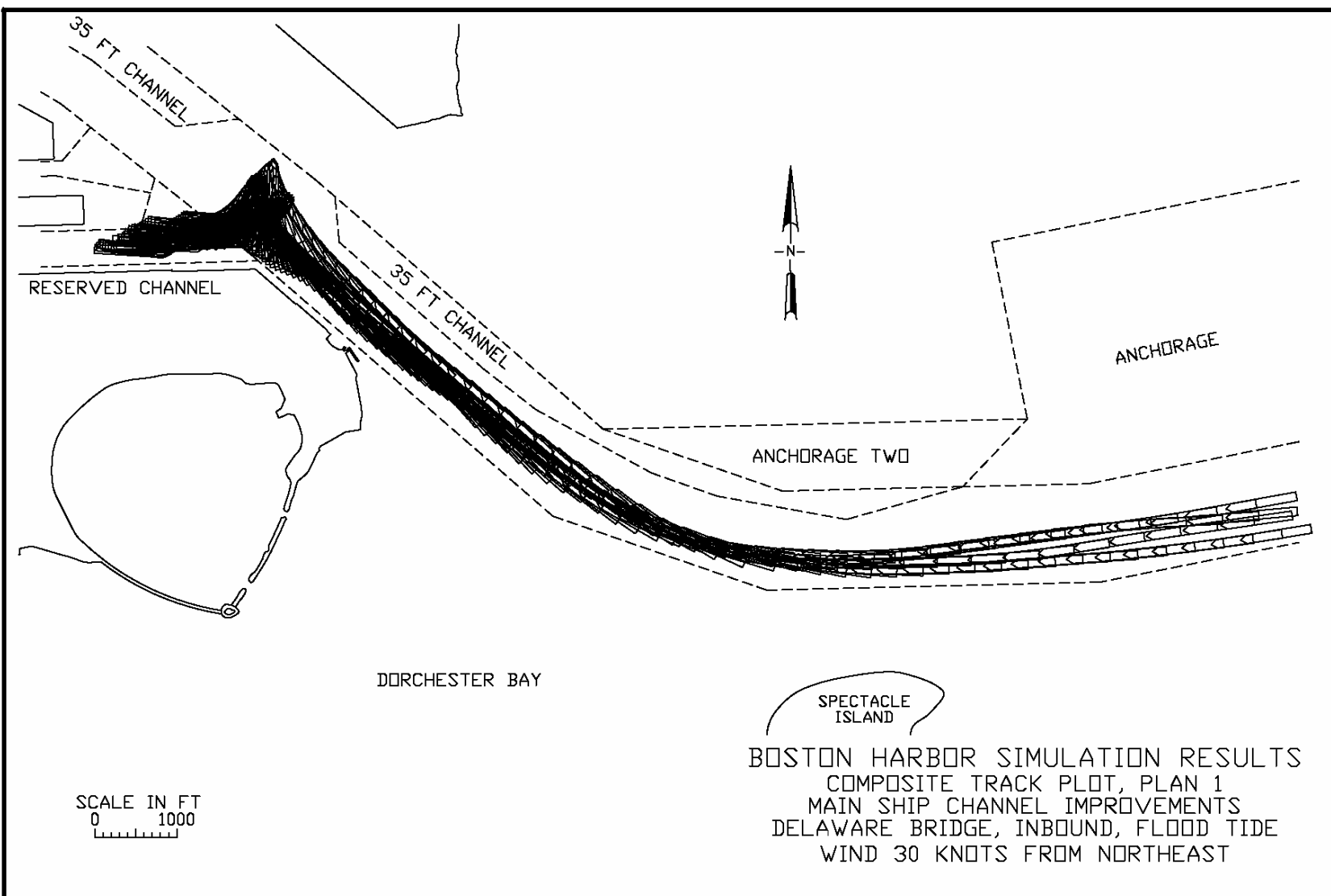


PLATE 2





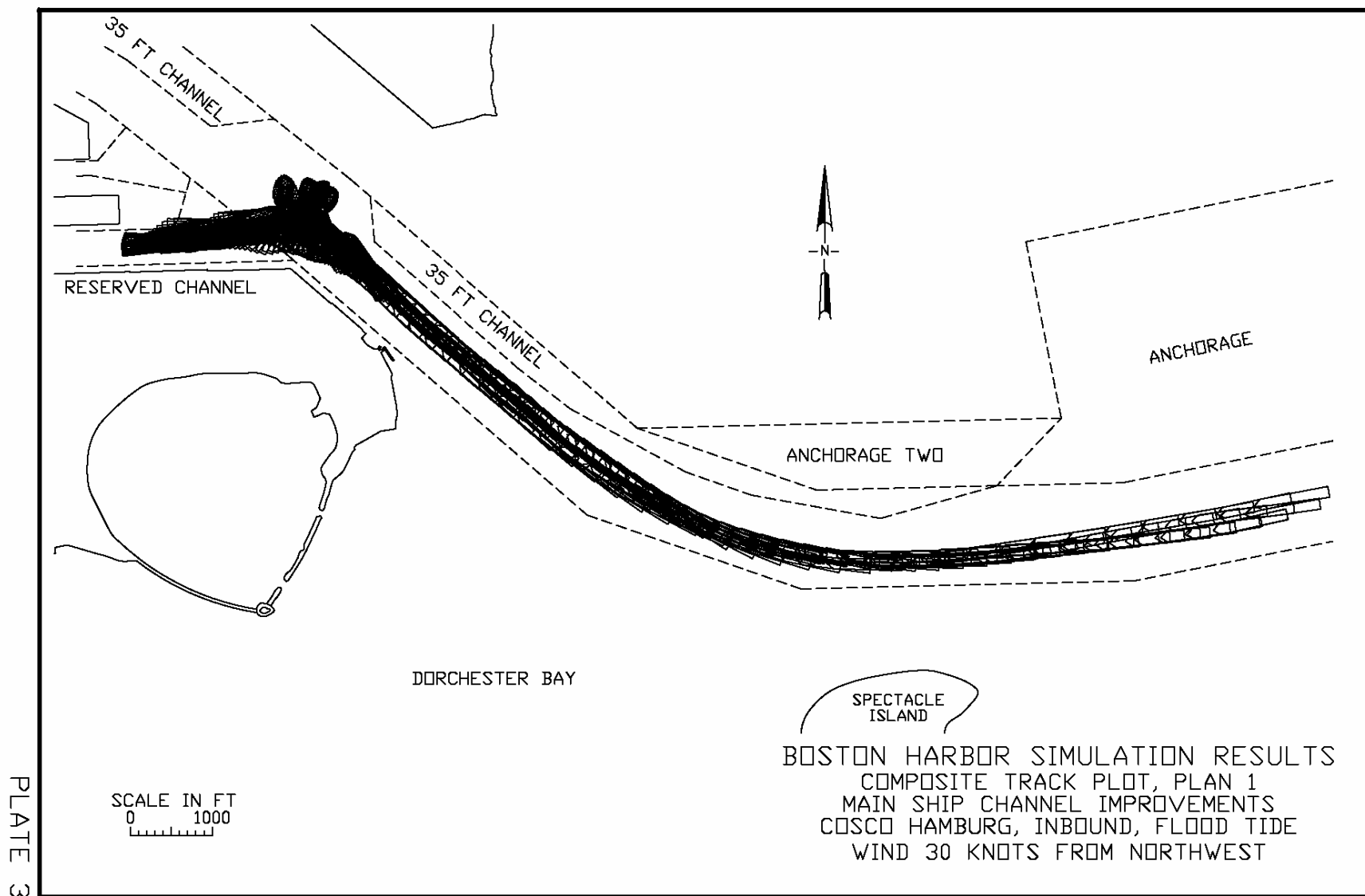
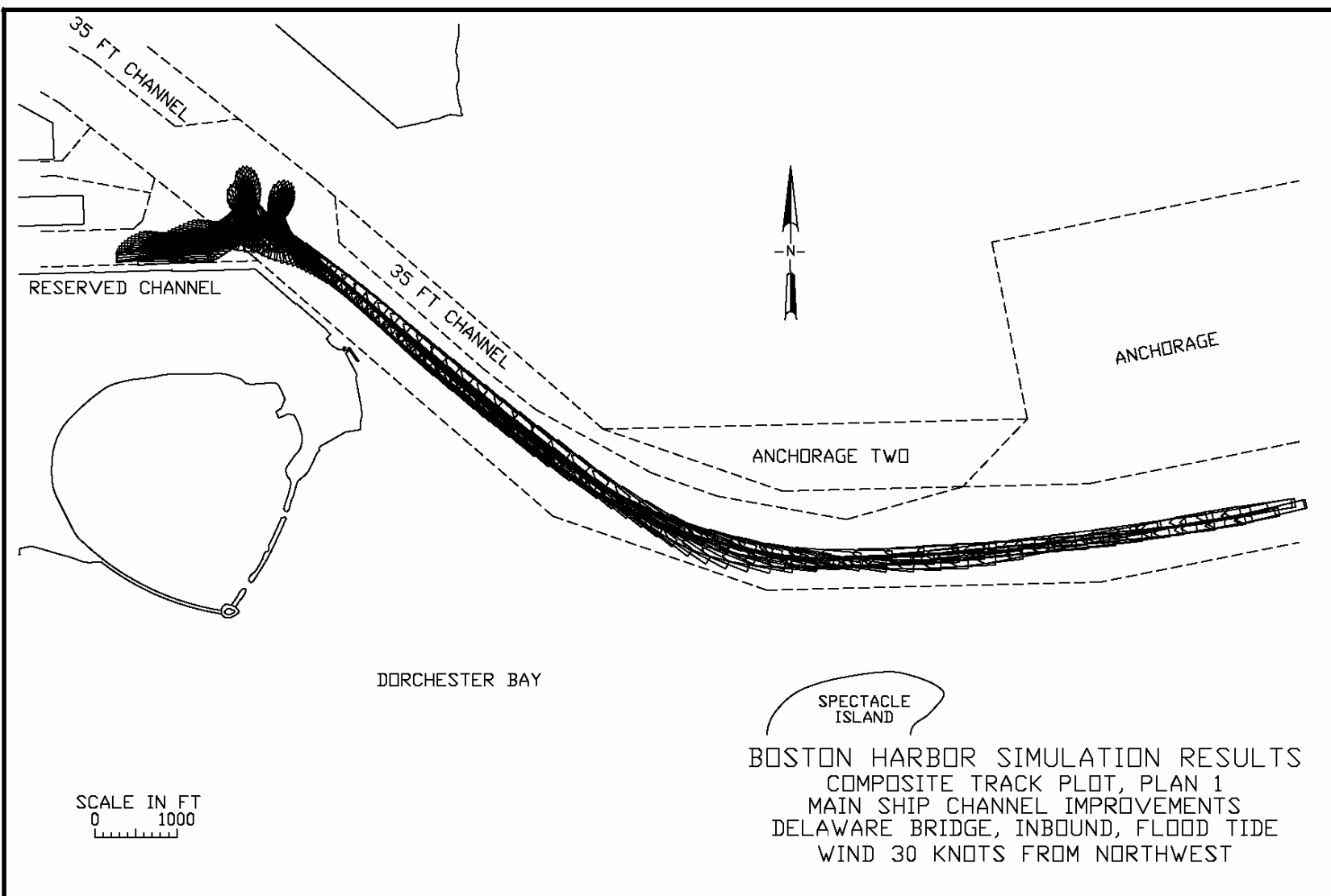


PLATE 4



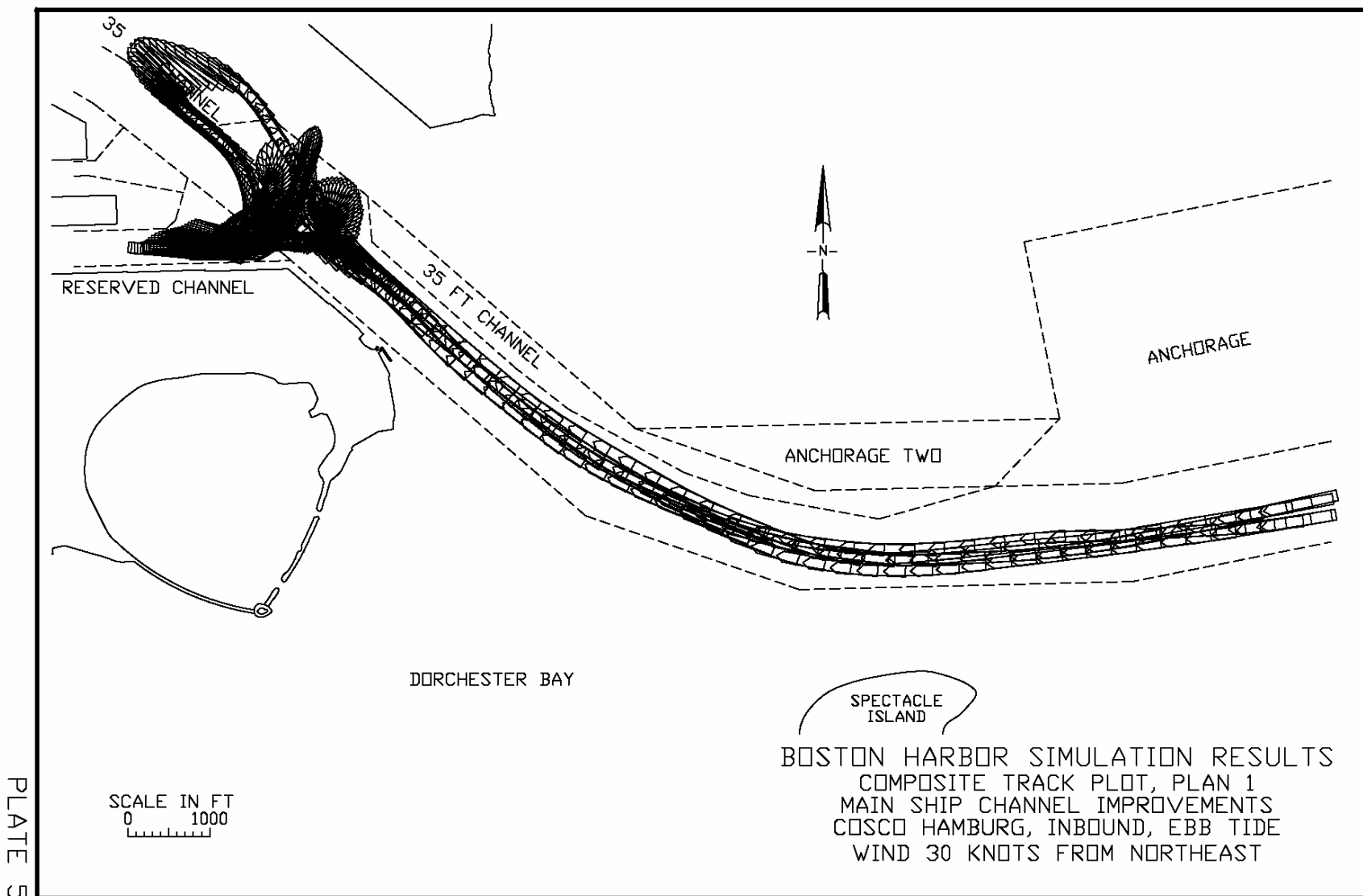
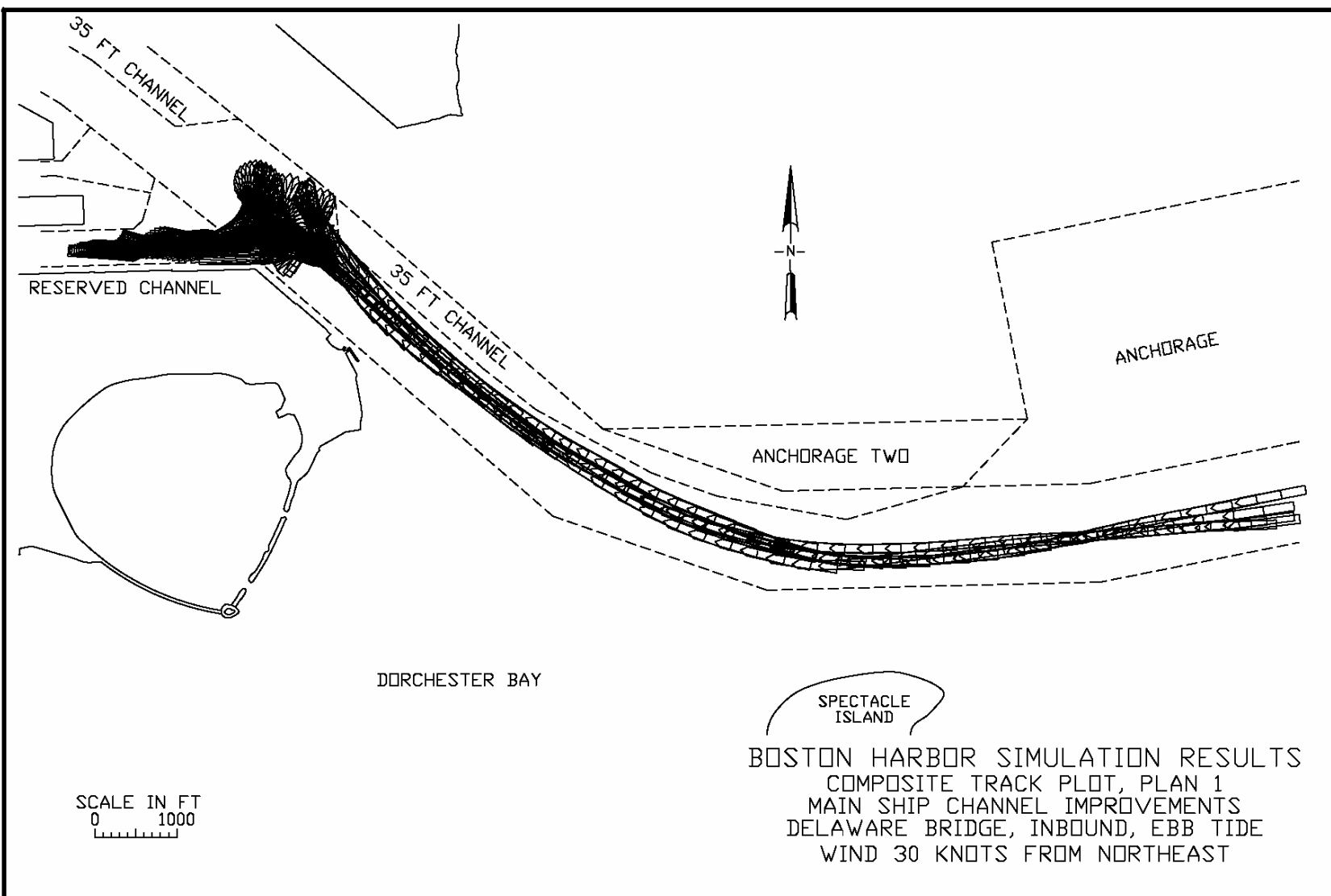
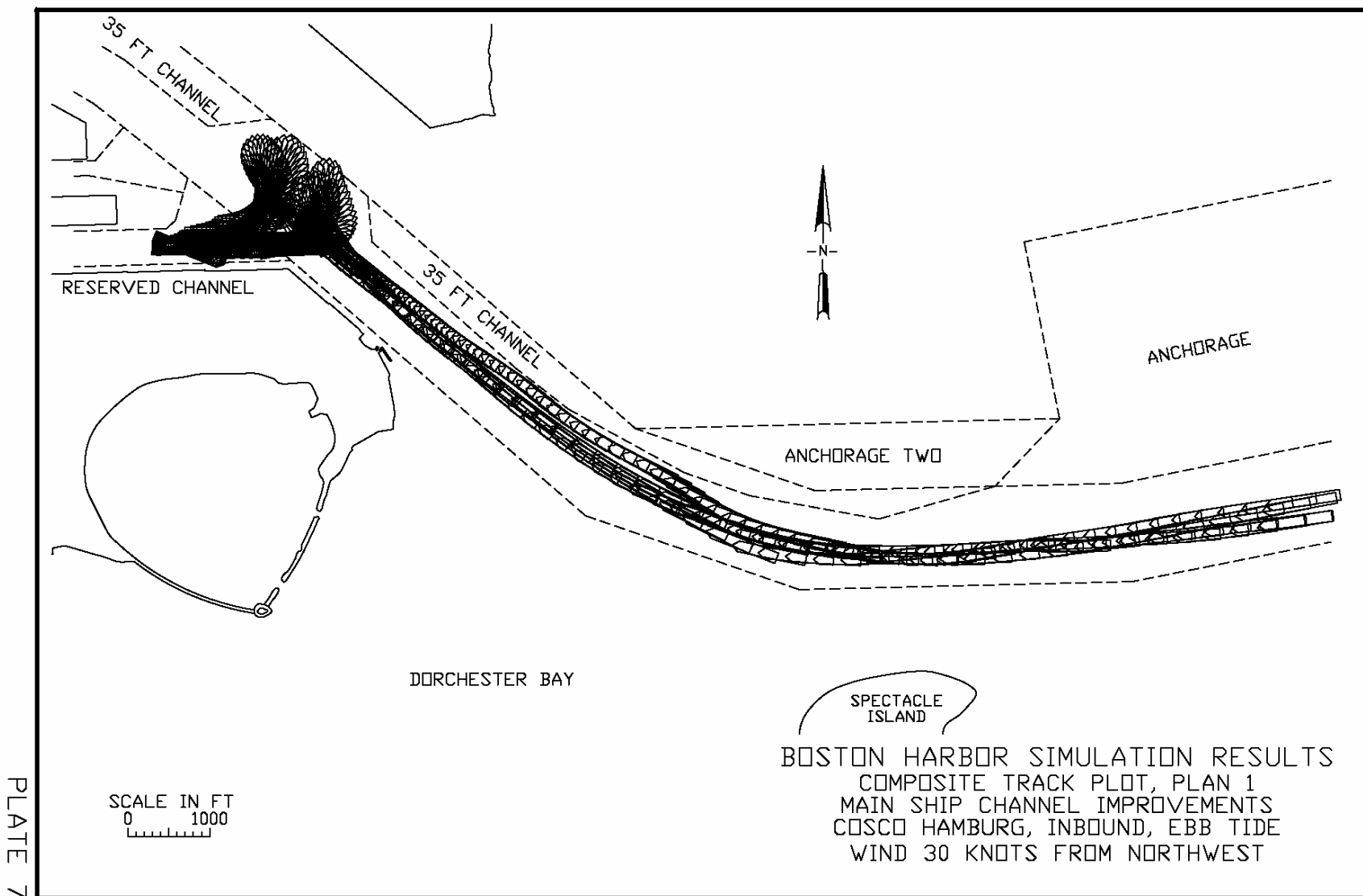
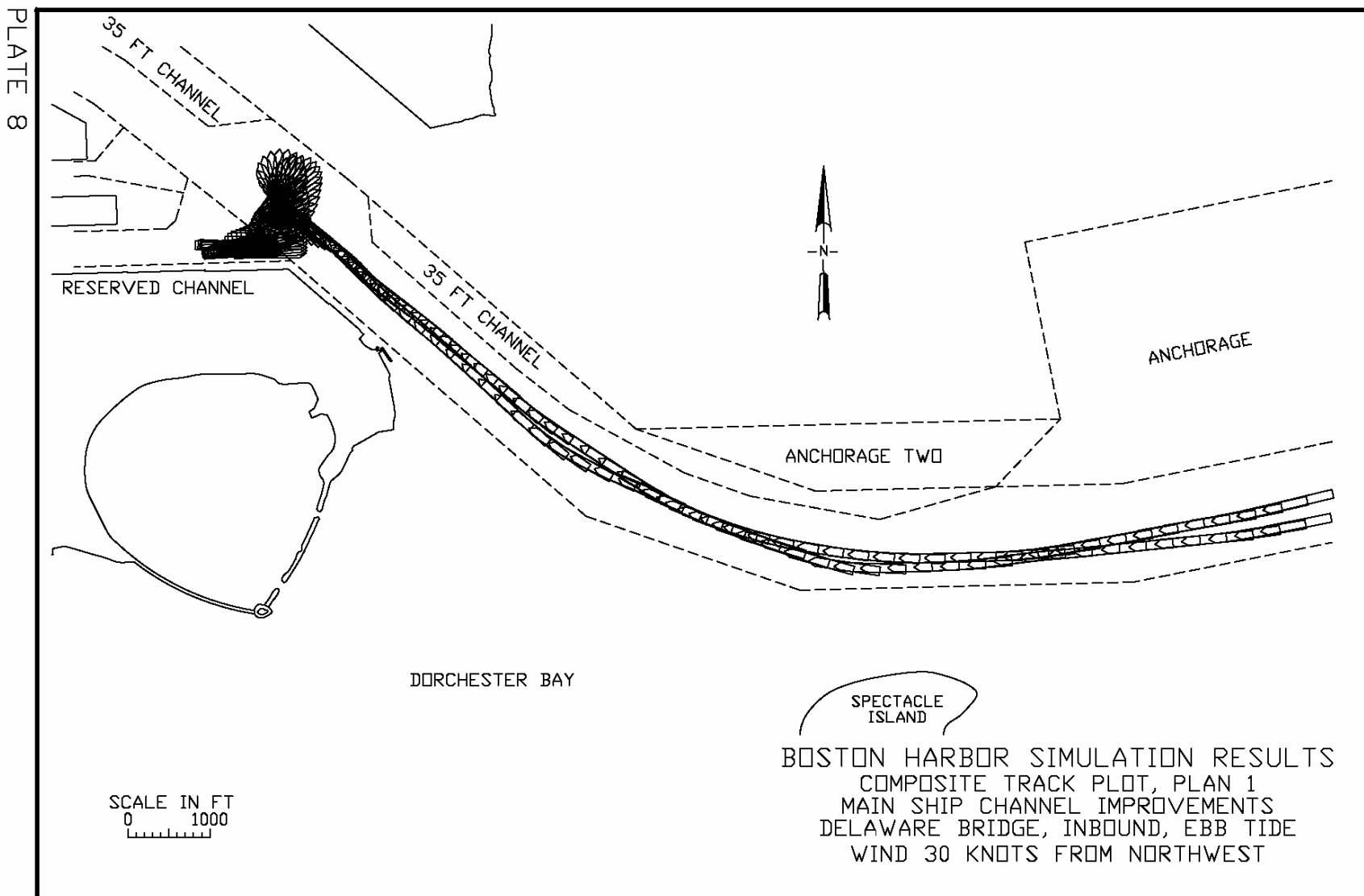


PLATE 6







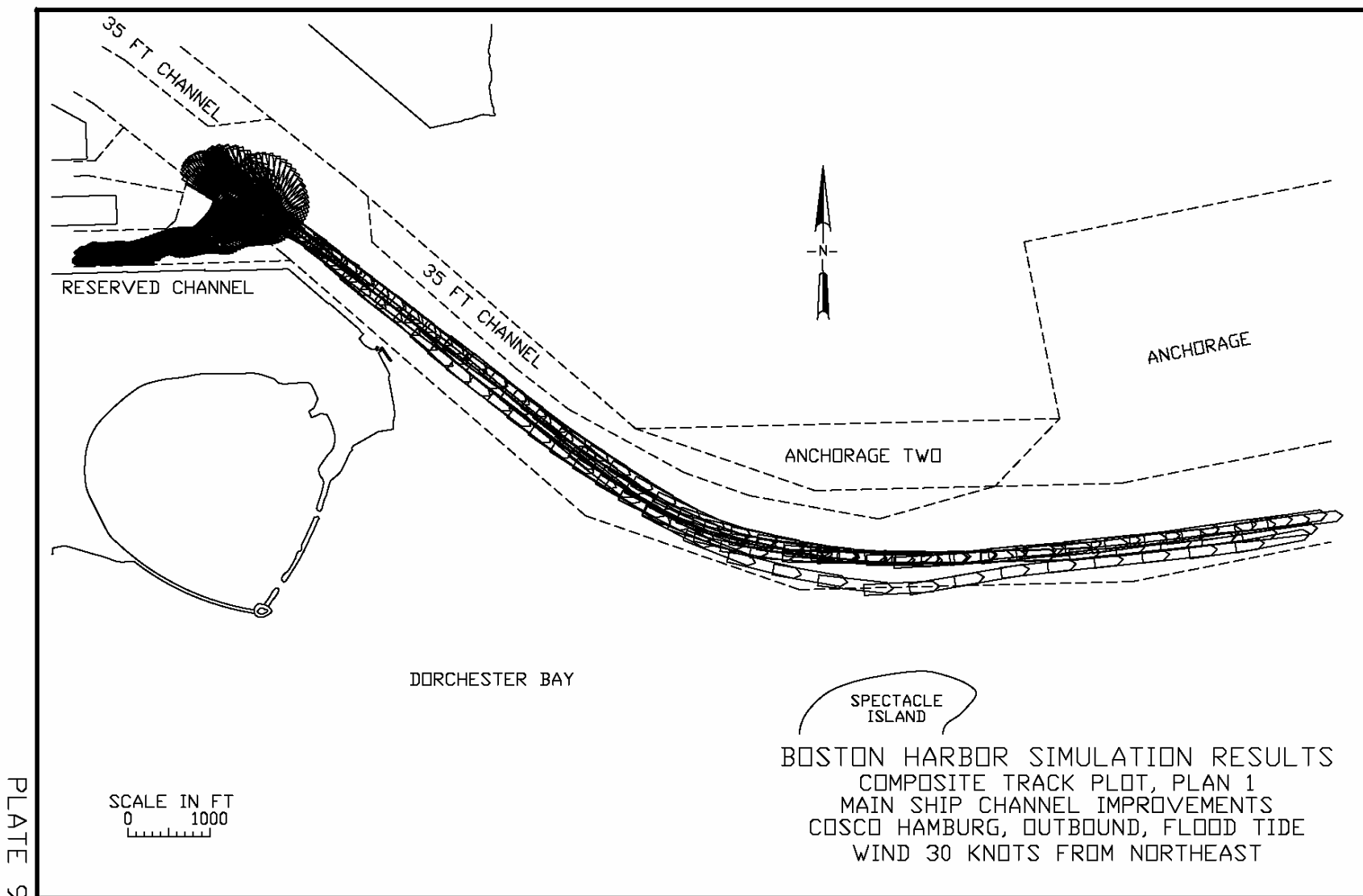
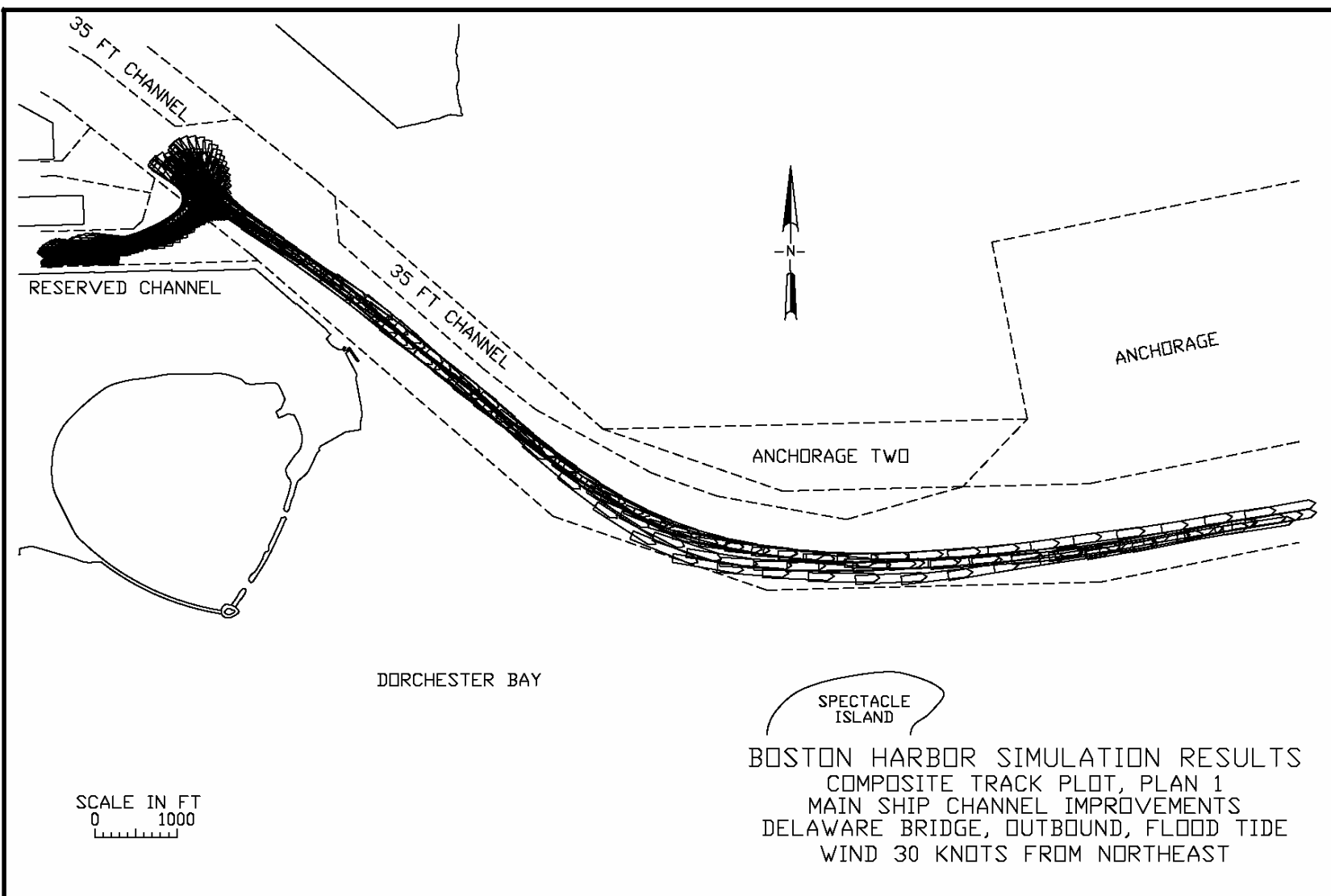


PLATE 10





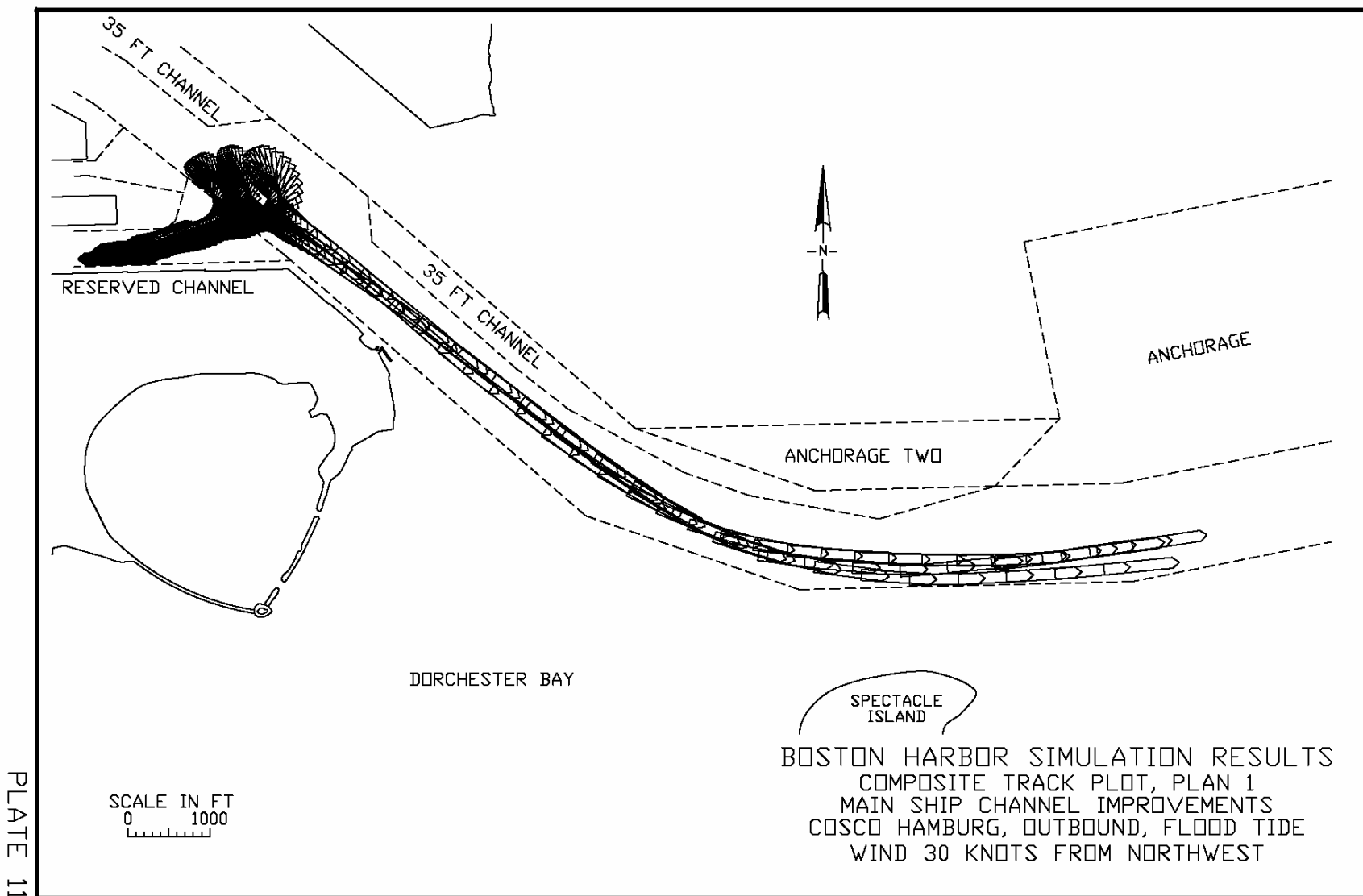
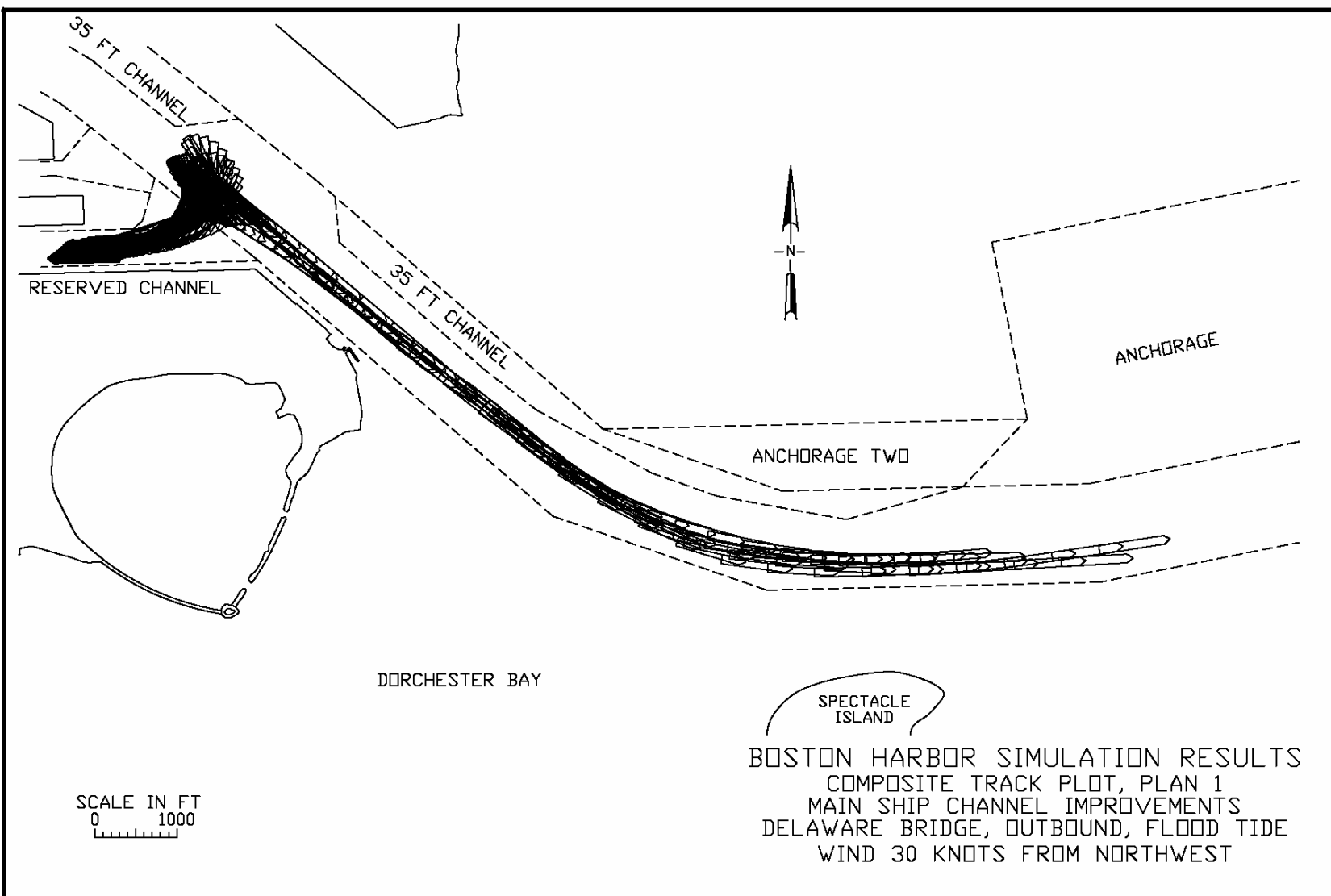


PLATE 12



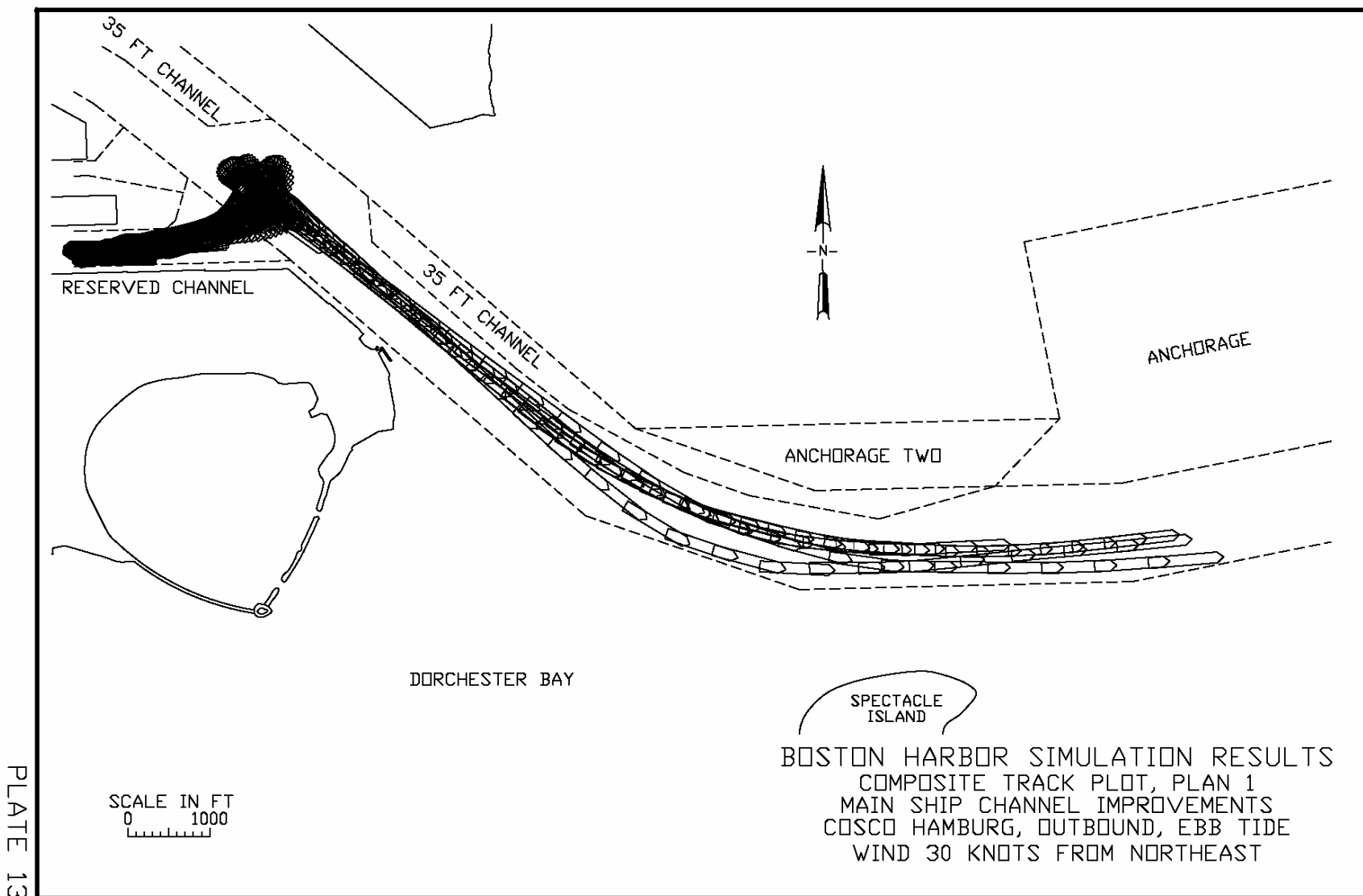
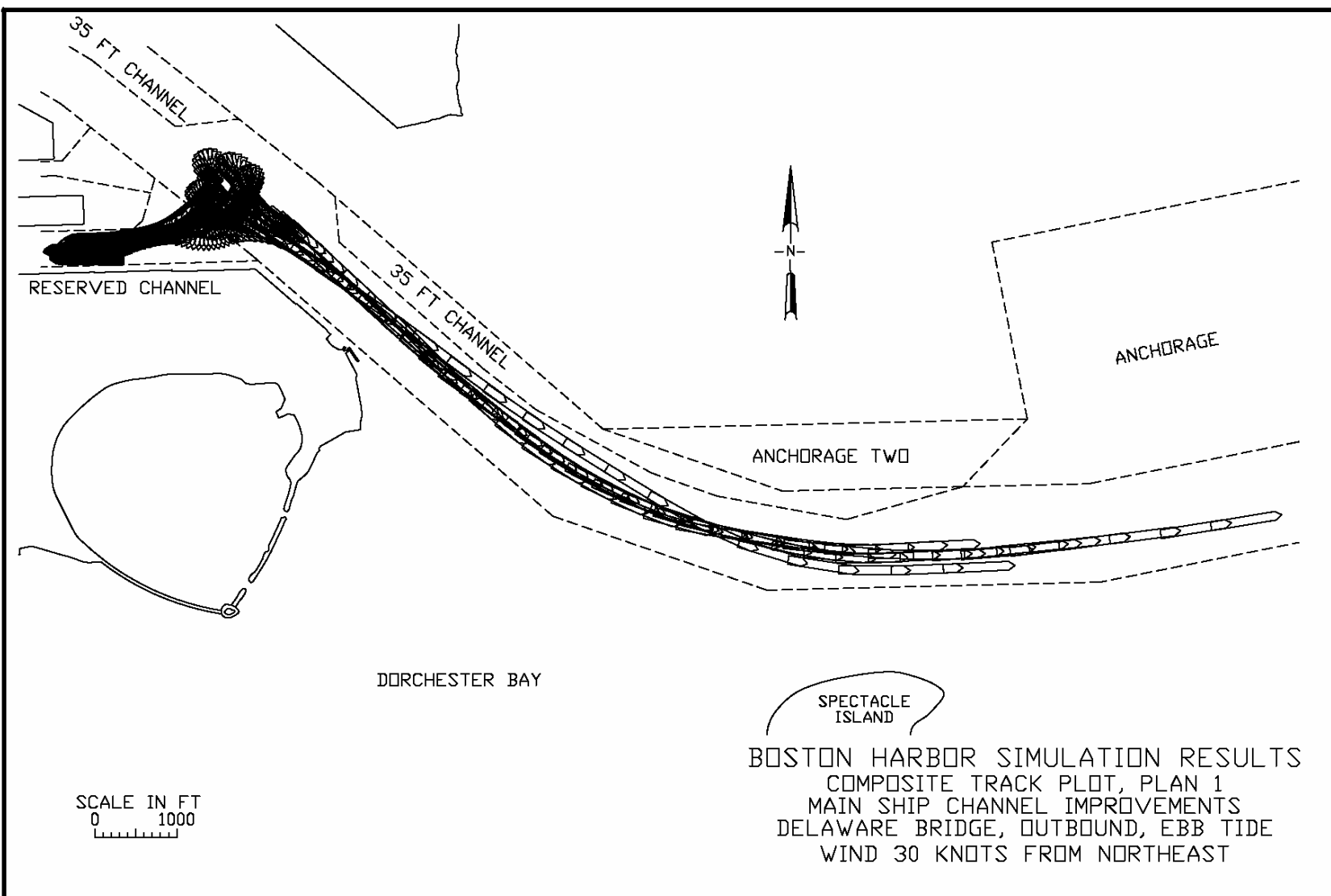


PLATE 14



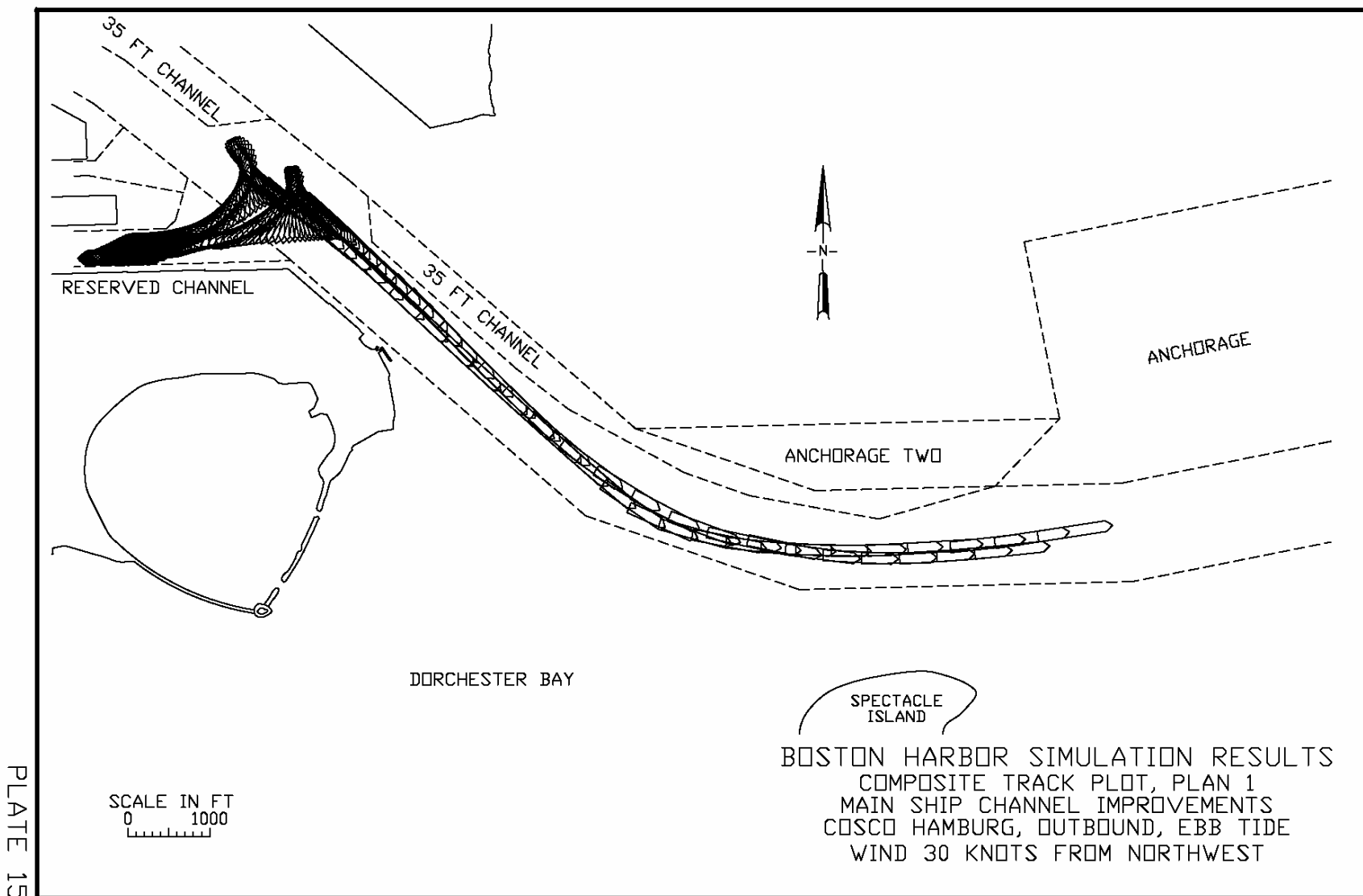
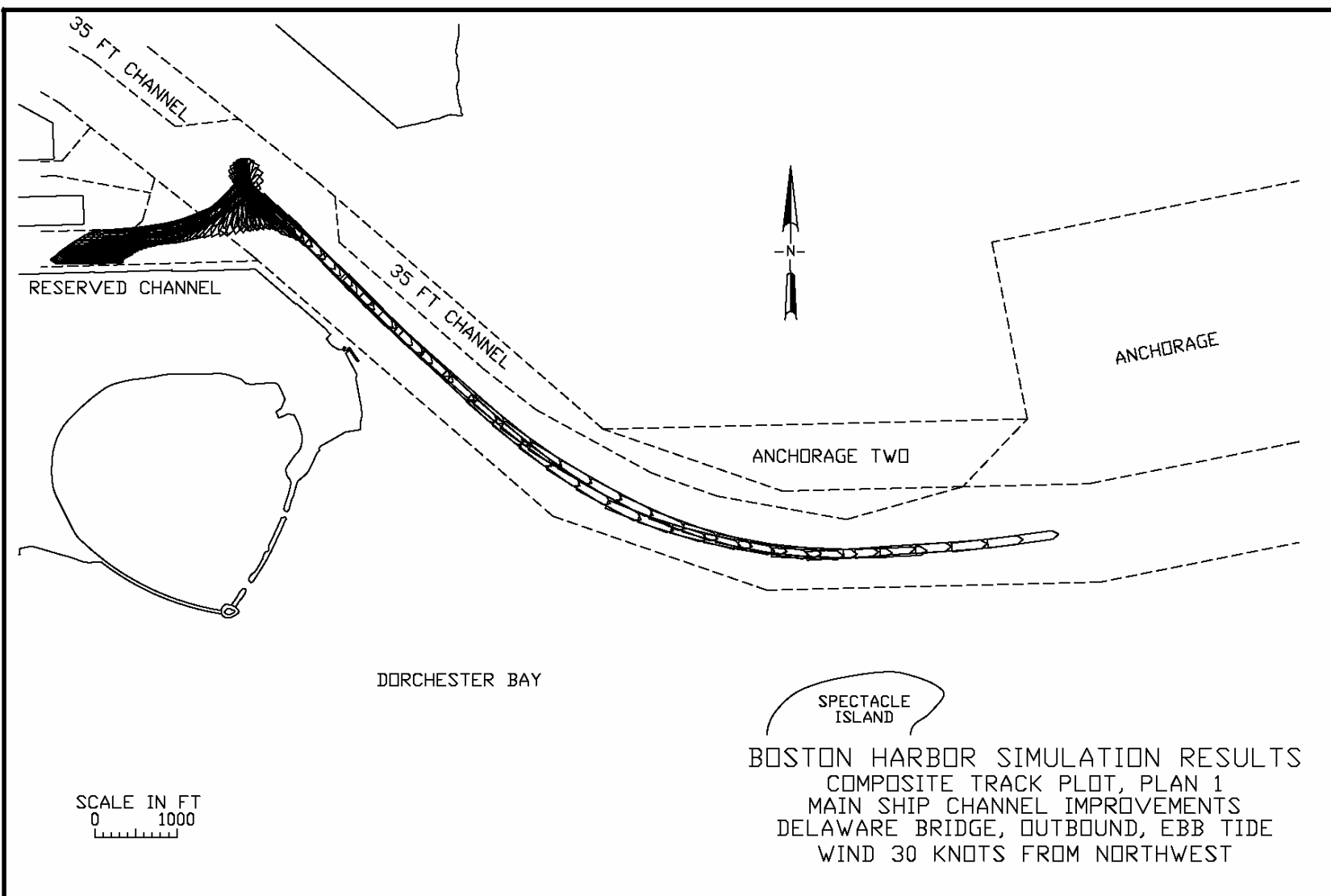


PLATE 16



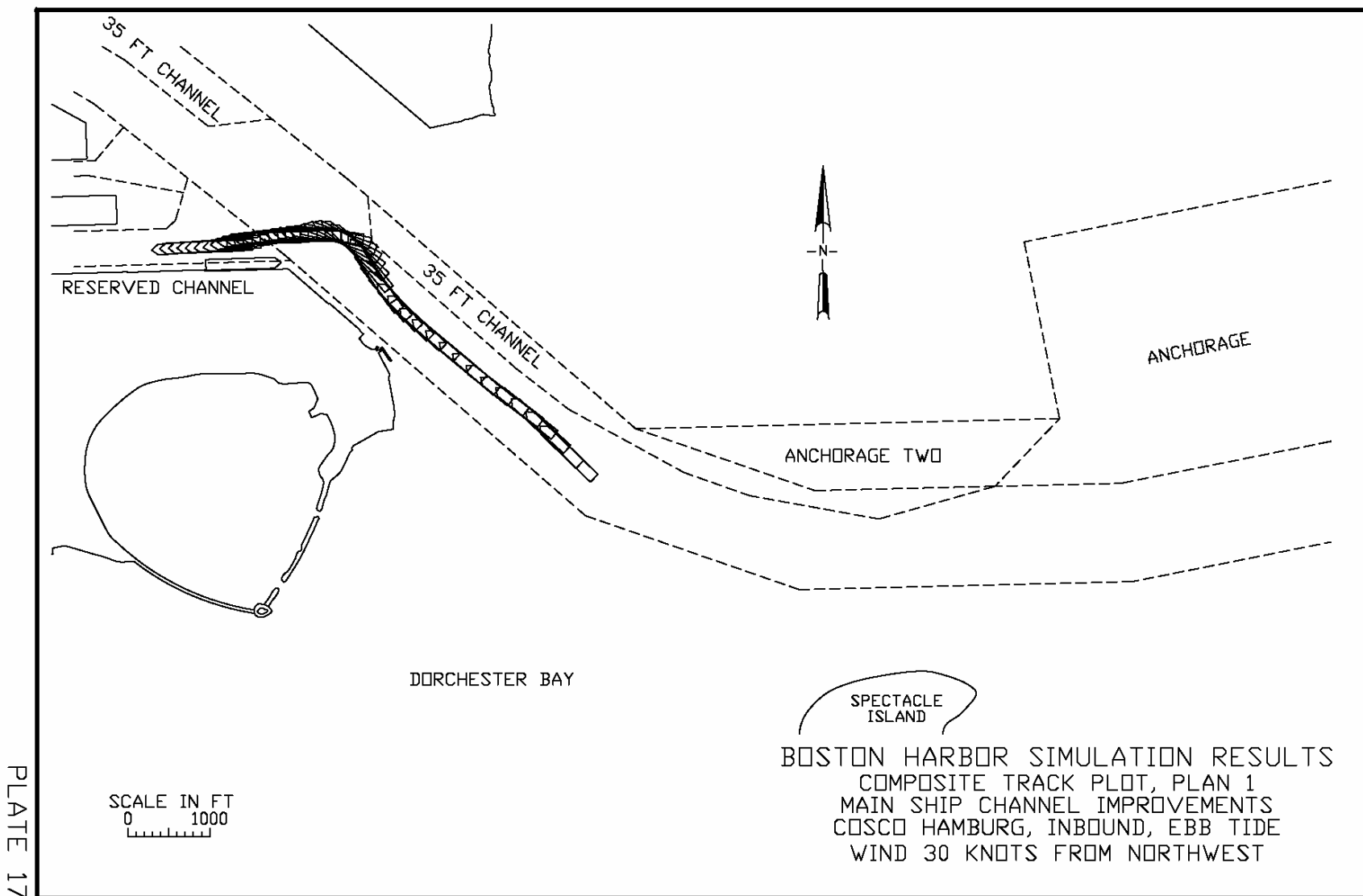
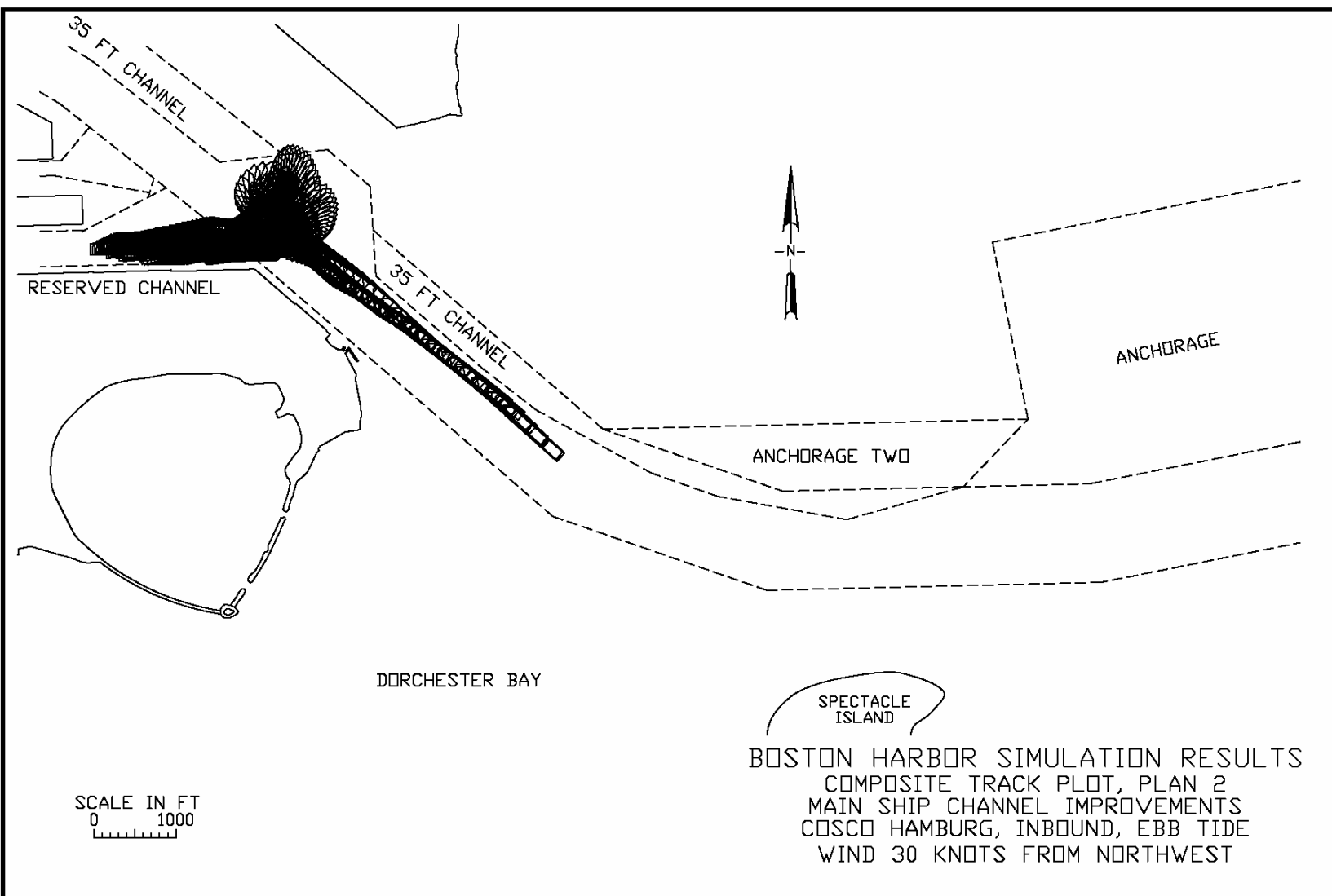


PLATE 18





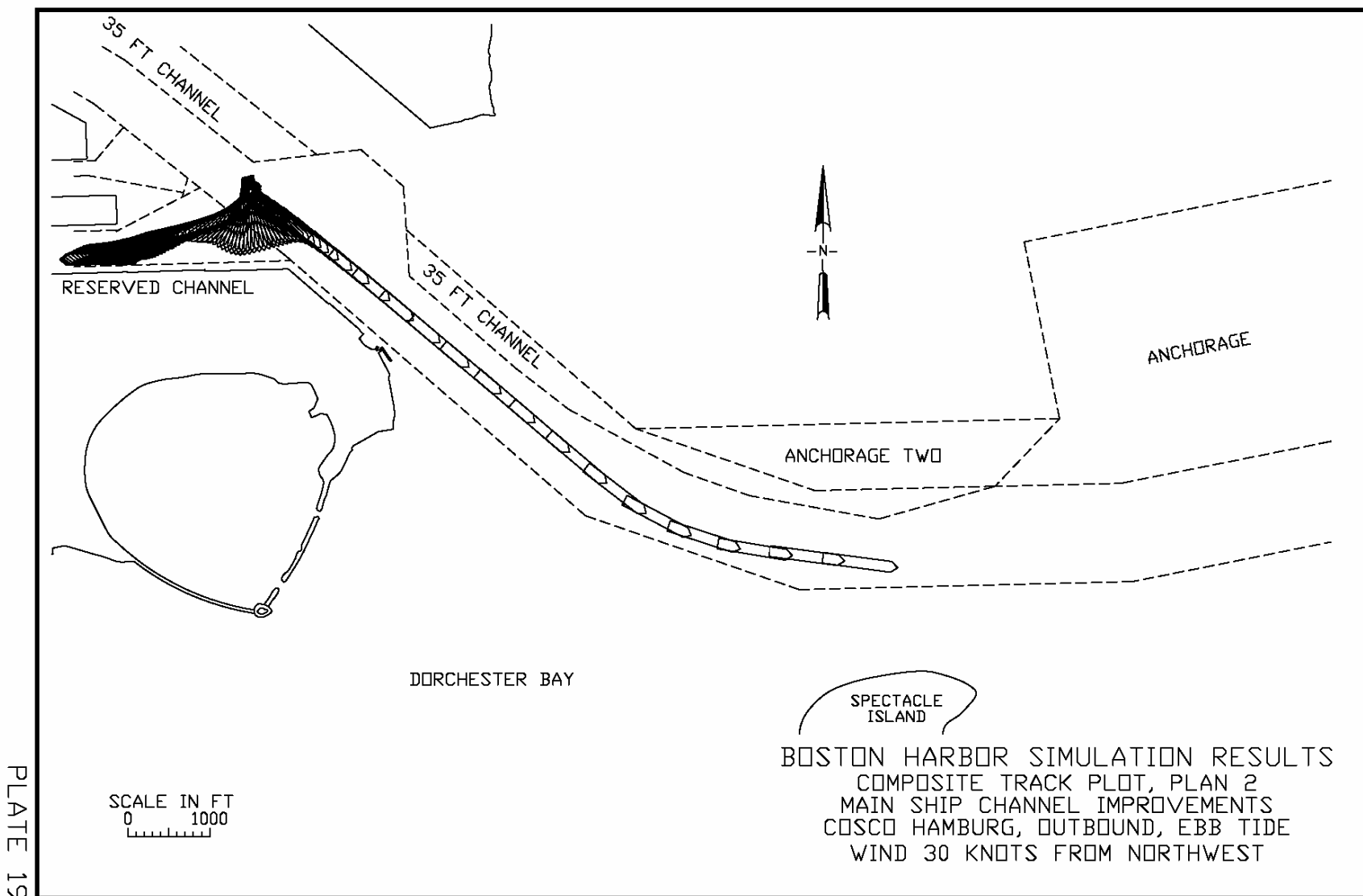
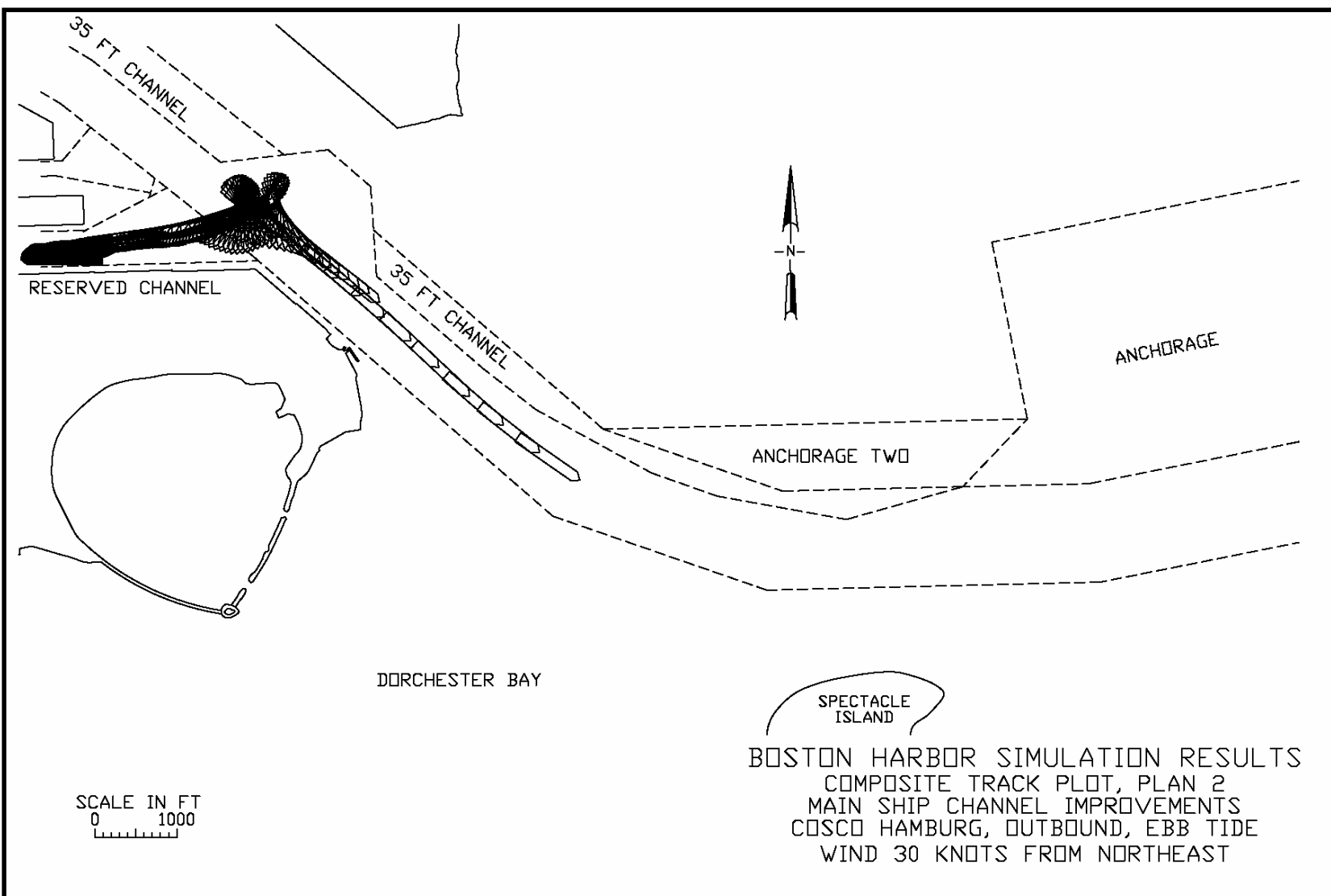


PLATE 20



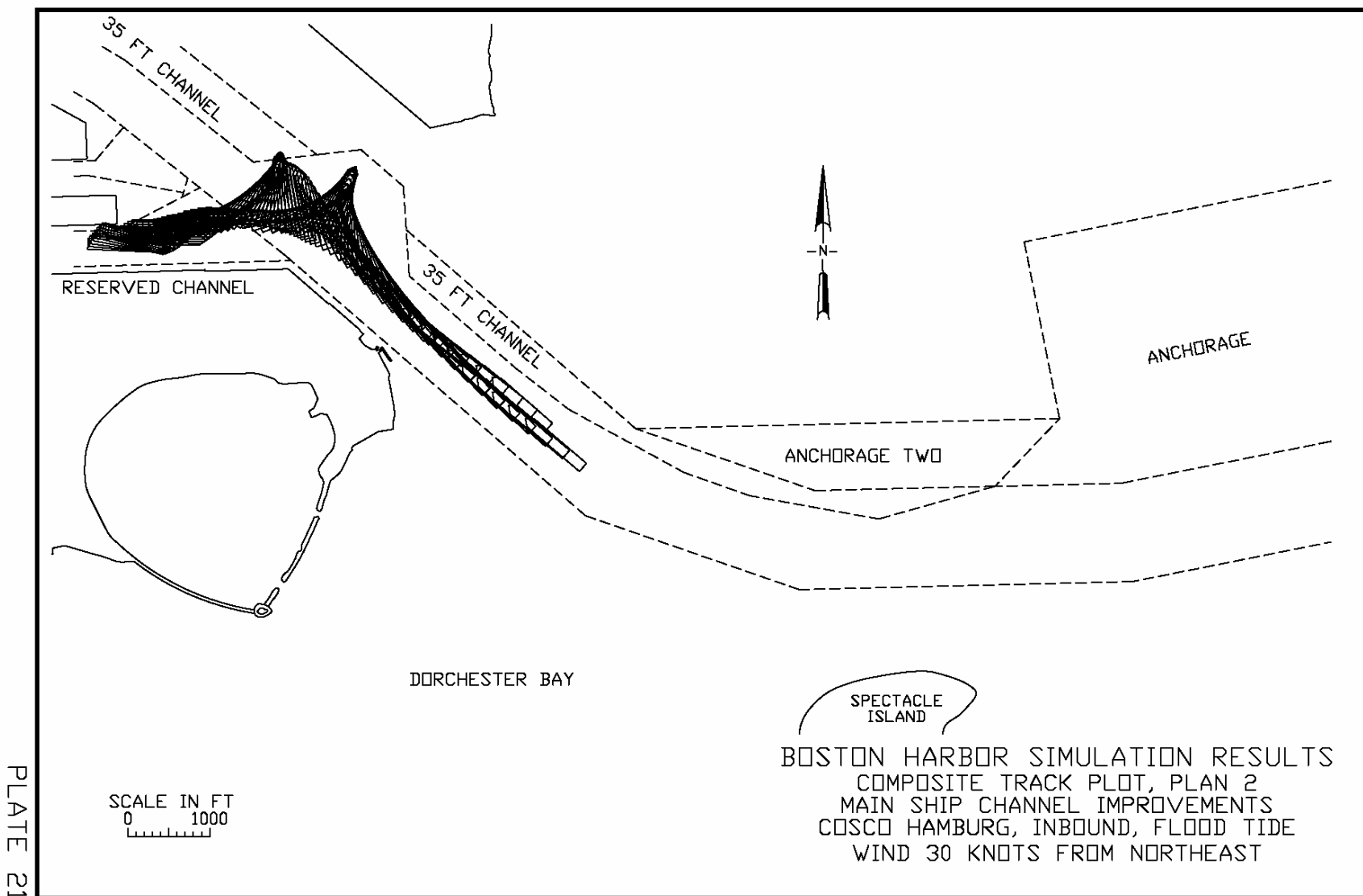
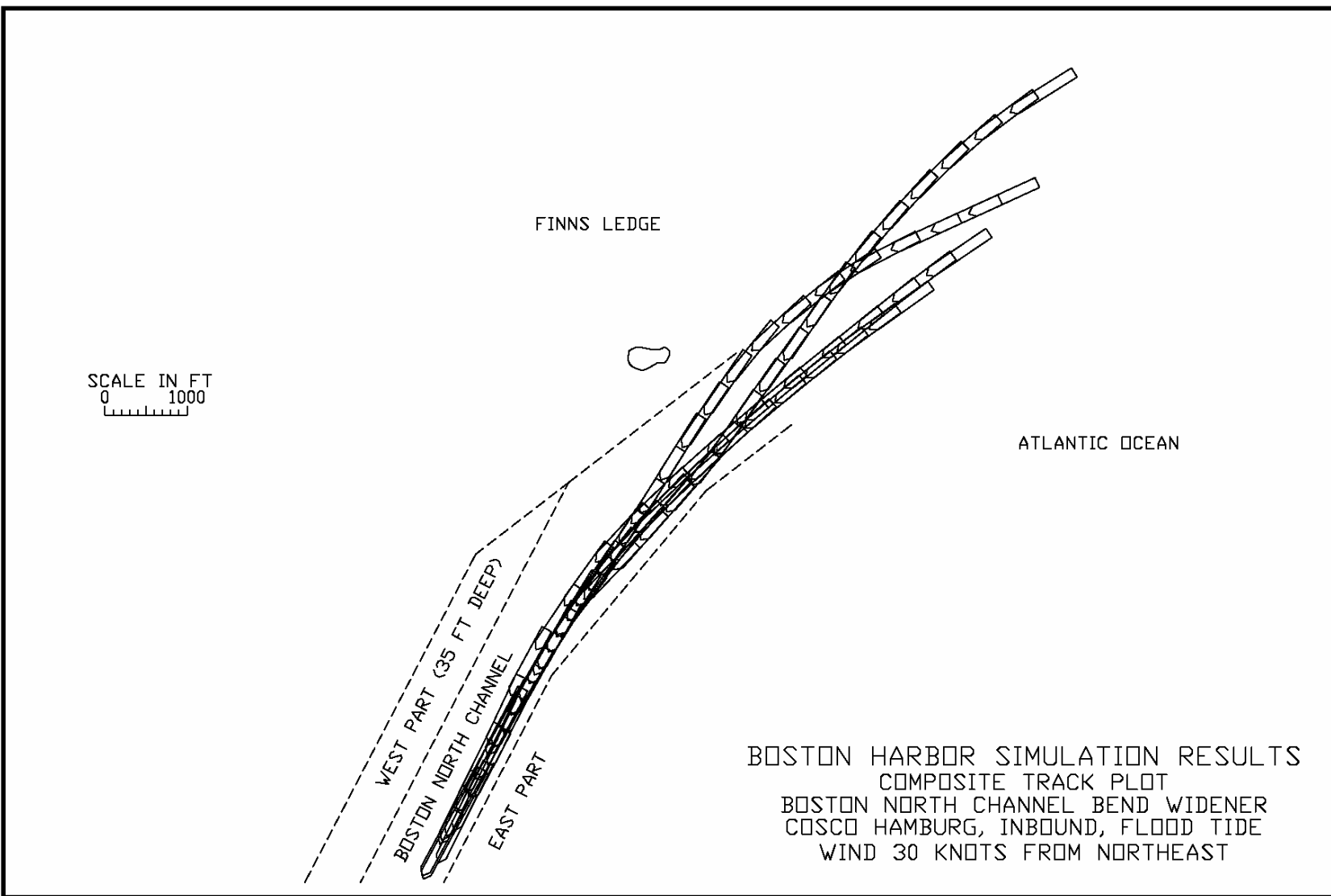


PLATE 22



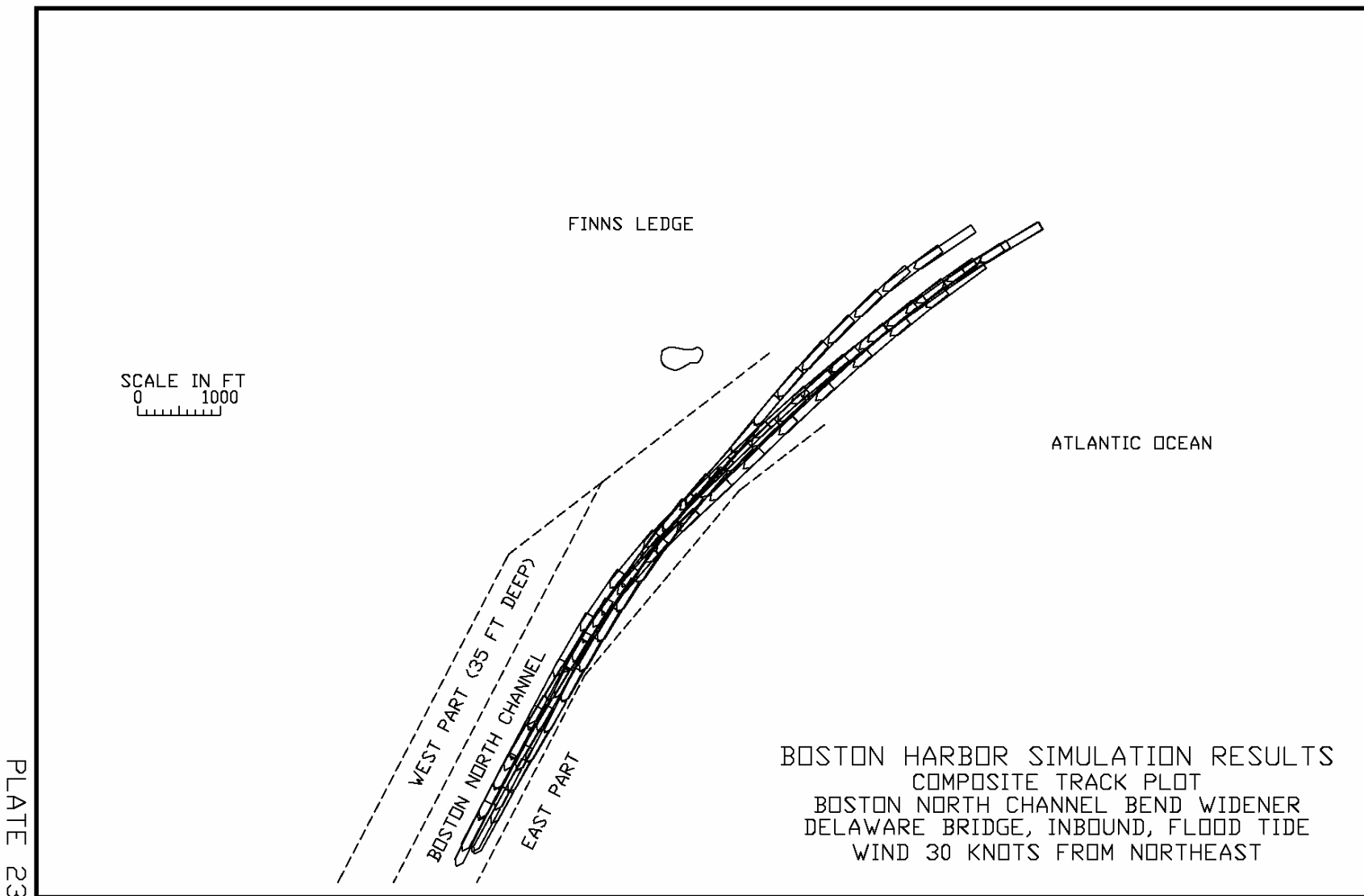
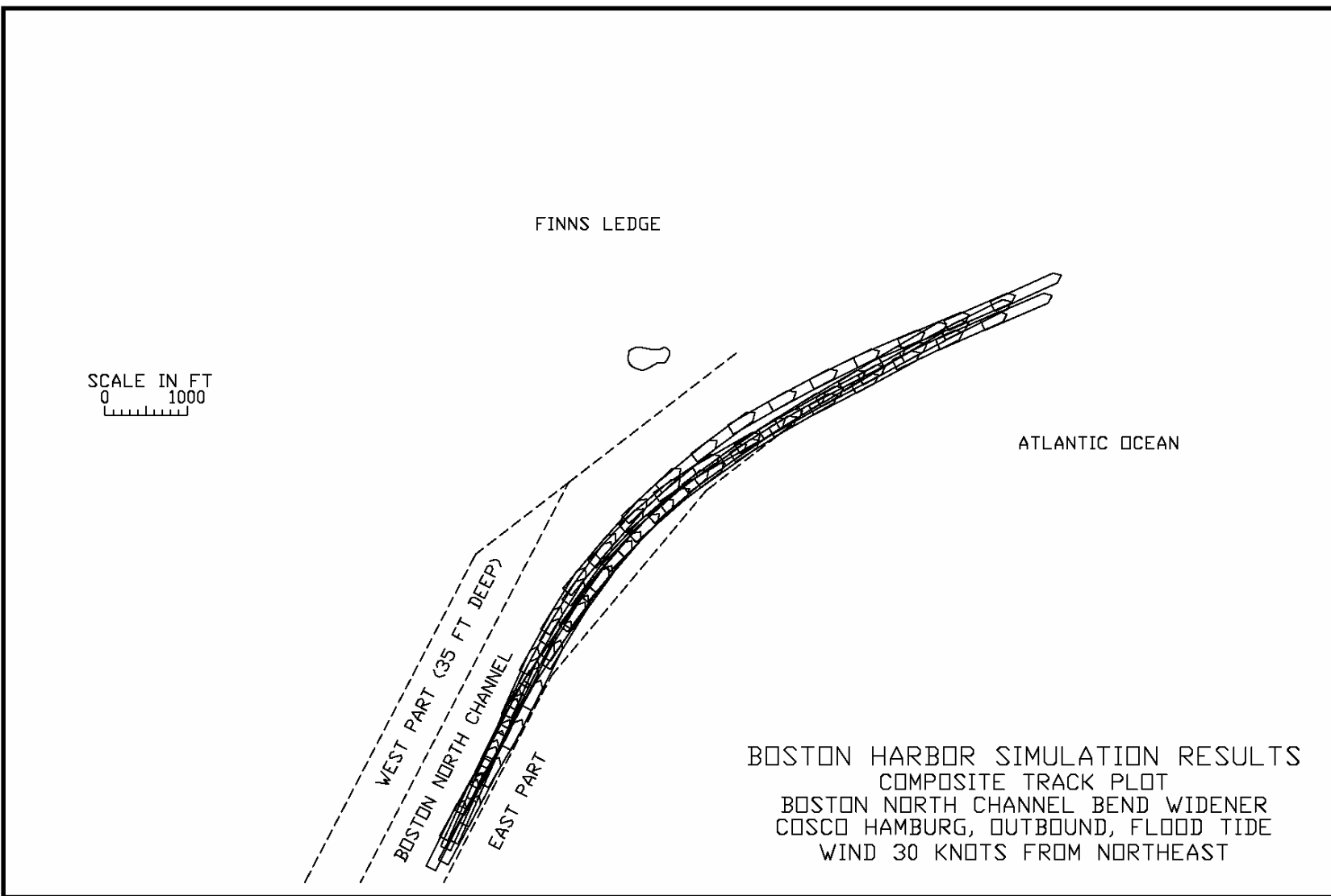


PLATE 24



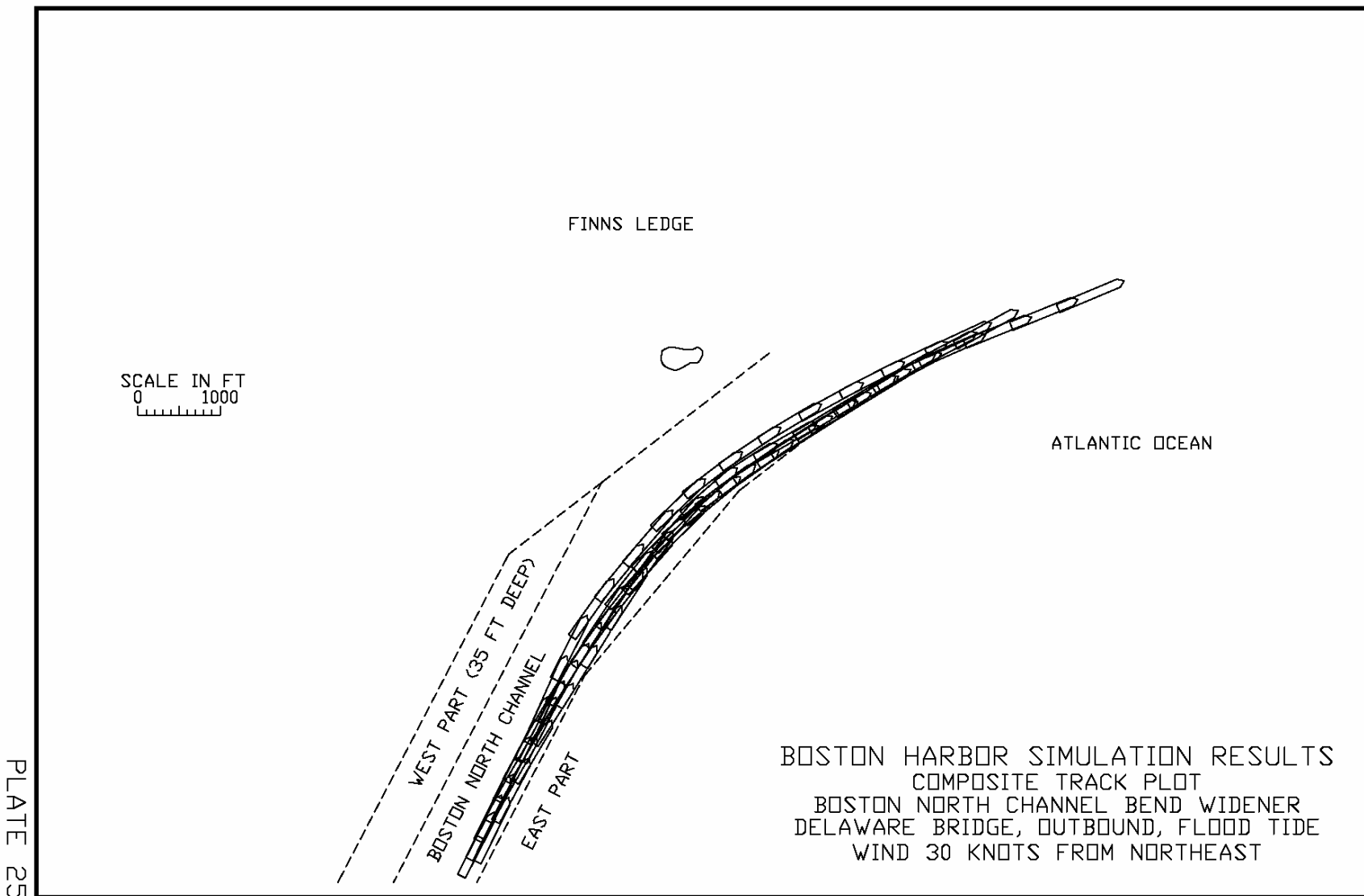
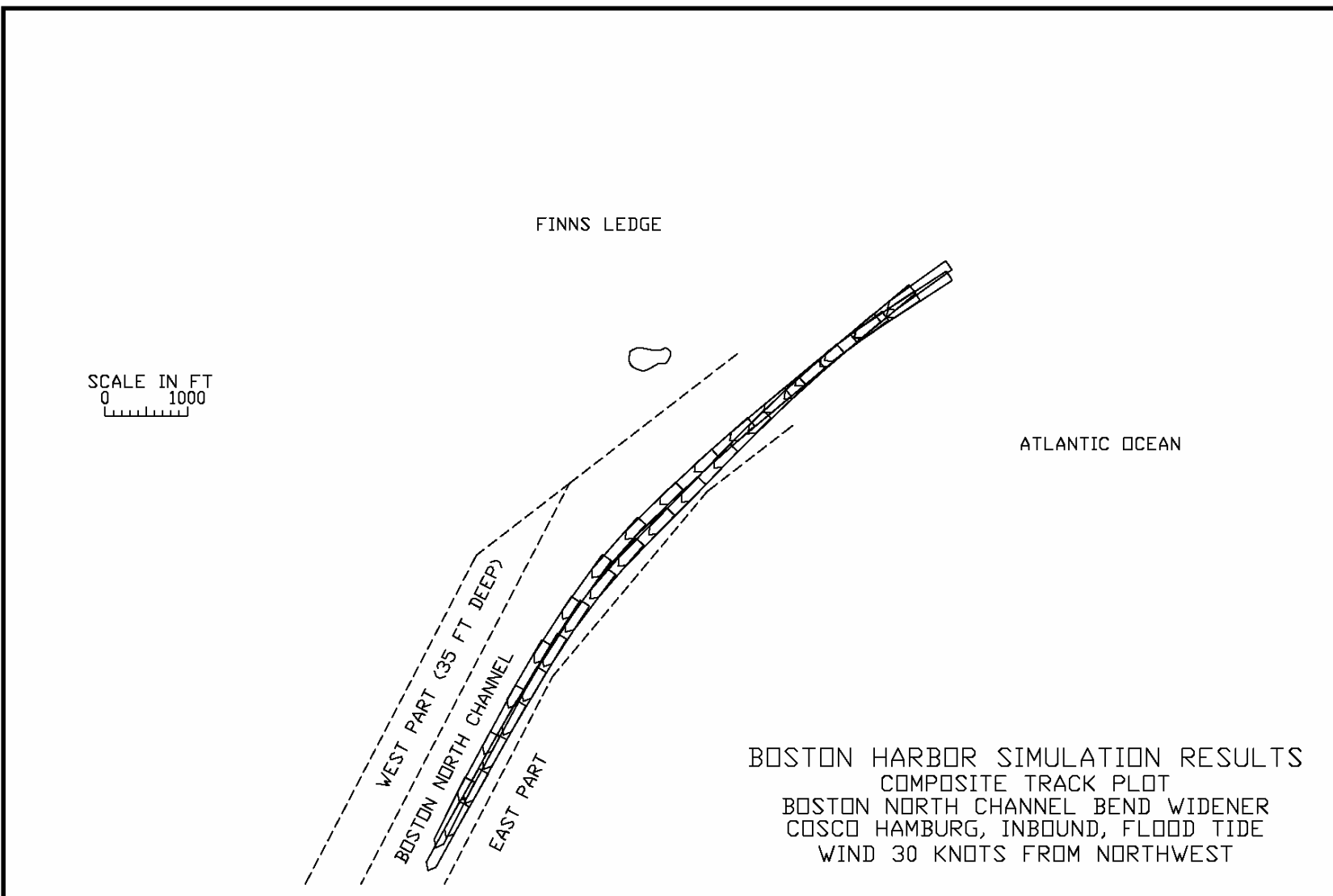
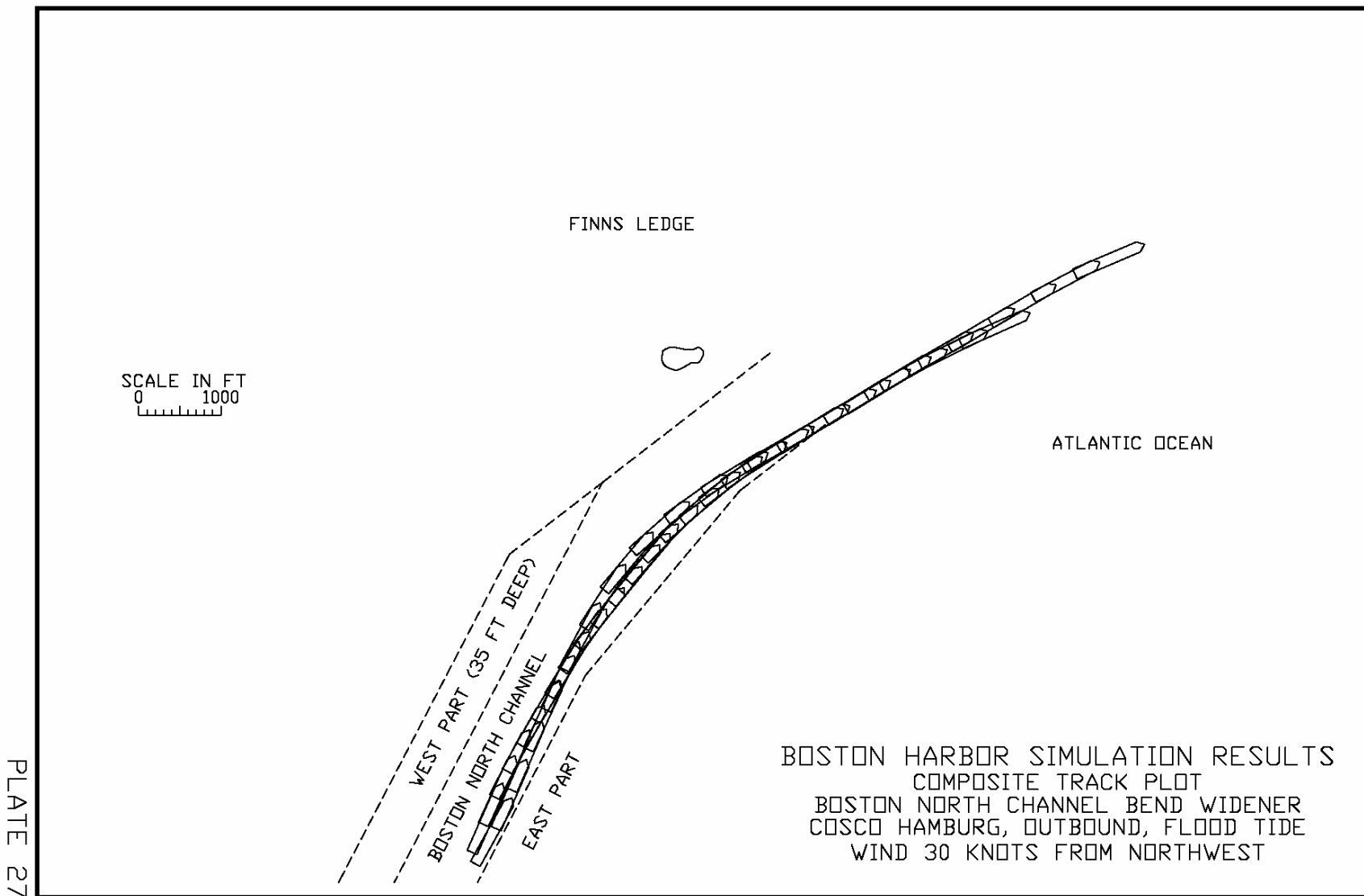


PLATE 26







## Appendix A: Pilot Questionnaires

Boston Harbor Channel Improvements  
Final Questionnaire

Captain Dirk Coffman

Ships

The *COSCO Hamburg* – 918 - x 131- x 46-ft containership.

The *Delaware Bridge* - 871.8 – 106 – x 43 ft containership.

1. A bend widener (Figure 1) is proposed for the East Part of the Boston North Channel. The purpose of the widener was to provide additional maneuvering room near Finns Ledge.

a. Based upon your simulation runs, do you feel that the widener provided adequate room for both the *COSCO Hamburg* and the *Delaware Bridge*?

Yes

b. Based upon your simulation runs, do you feel that the widener is necessary to bring the *COSCO Hamburg* and the *Delaware Bridge* into and out of Boston Harbor?

Both ships could be brought in with existing channel but the widener would make a hard turn easier and safer. It would also make meeting other ships in to area easier.

c. Will the widener benefit other vessels calling at Boston Harbor? If so, which vessels and in what manner would they benefit.

All ships would benefit as turn could be negotiated easier and safer.

d. Should the widener be modified? Feel free to sketch on Figure 1.

Configuration is good. I believe buoys are planned for corners.

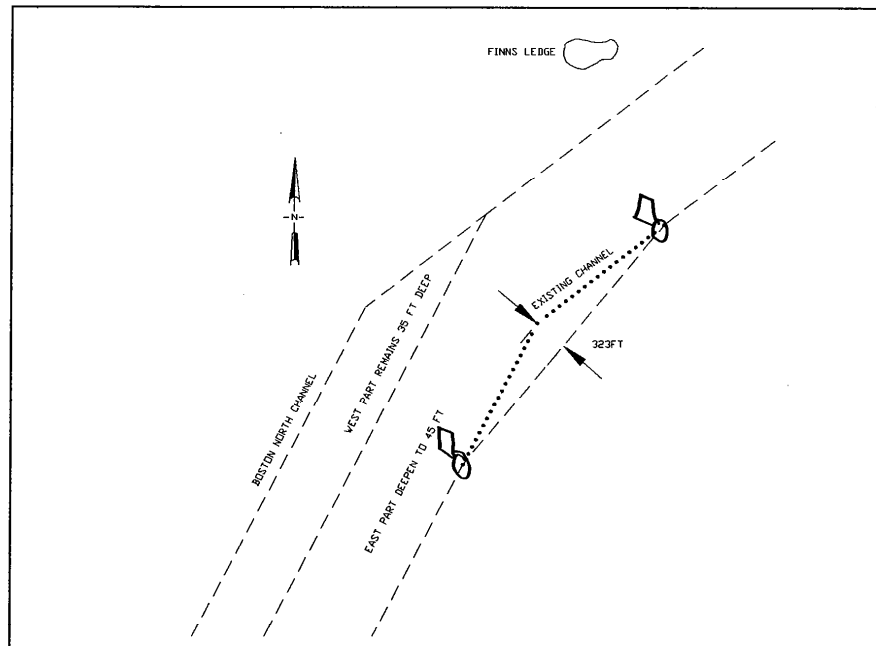


Figure 1. Boston North Channel Bend Widener

2. Widening of the deepened 45 ft channel near Spectacle Island is proposed. The widening will be accomplished by deepening on the south side of the 35 ft channel. The channel width would be increased to 800 feet with 880 feet through the turns. The widening is shown in Figure 2. The purpose of the additional width is permit passage of these larger vessels through this reach of the harbor's Main Ship Channel and to ease passage in the two turns above Spectacle Island.

- a. Based upon your simulation runs, do you feel that the additional width provided adequate room for both the *COSCO Hamburg* and the *Delaware Bridge*?

*yes*

- b. Based upon your simulation runs, do you feel that the additional width is necessary to bring the *COSCO Hamburg* and the *Delaware Bridge* to make the turn near Spectacle Island?

*yes, to bring in vessels of this size in challenging conditions of wind and current at slow speeds required the widening is necessary for safe transit.*

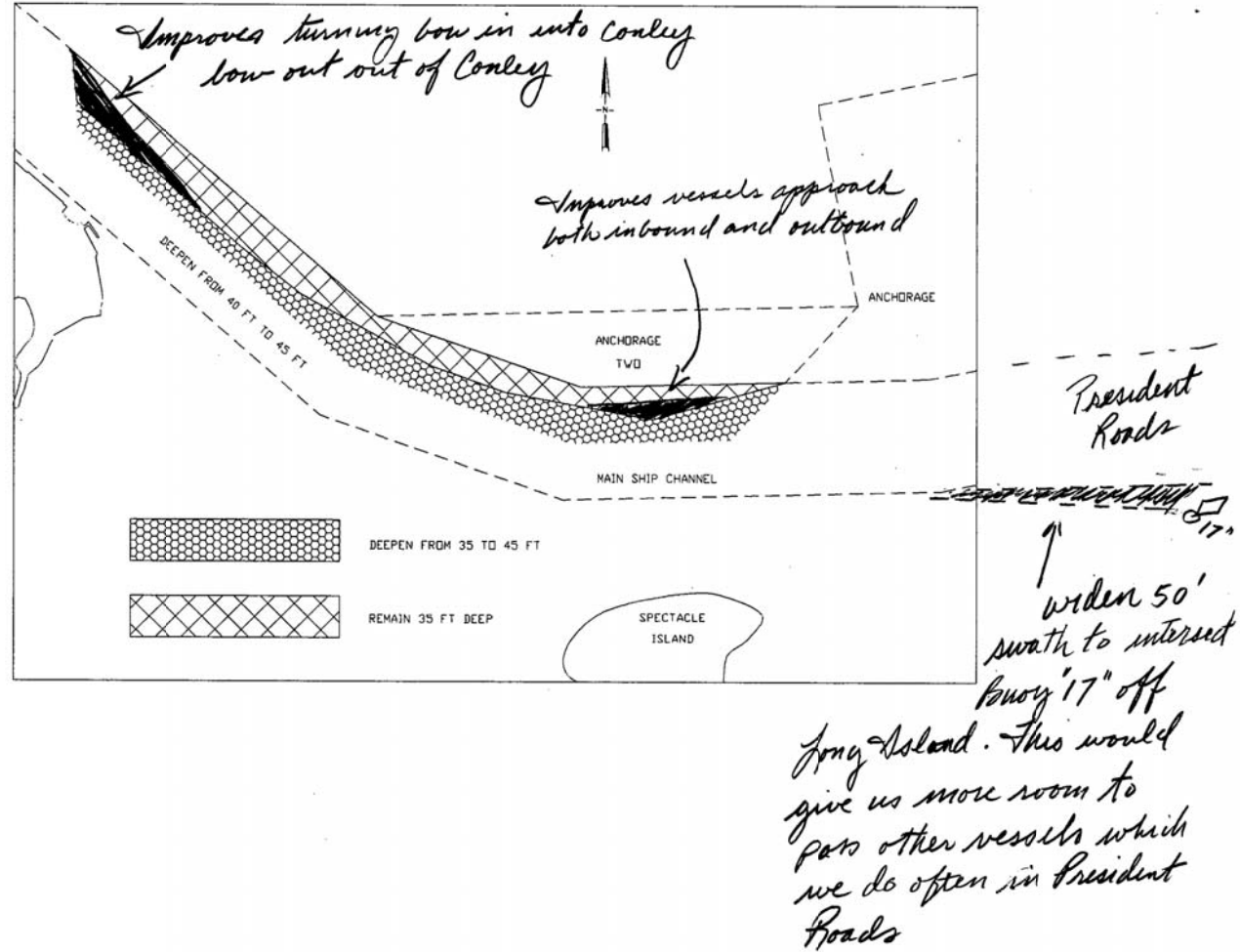
- c. Will the widener benefit other vessels calling at Boston Harbor? If so, which vessels and in what manner would they benefit.

*Other deep draft vessels (tankers, bulk scrap or salt, etc) will also benefit greatly.*

- d. Should the channel width in the straight sections or in the two turns be modified? Feel free to sketch on Figure 2.

*The proposed wider would be a great improvement. Additional improvements are noted on sketch.*

Figure 2. Spectacle Island Widening



3. Widening near the mouth of the Reserved Channel is proposed. The widening will increase the size of the turning area from a radius of 1200 feet to a radius of 1500 feet. and also provide 50 ft additional width for the 45 ft channel north of the turning area. The widening is shown in Figure 3. The turning area is being increased to allow larger containerships access to the Reserve Channel. The additional 50 ft width is to allow more maneuvering room for larger bulk carriers expected to call on the Massport marine Terminal just north of the Reserve Channel.

- a. Based upon your simulation runs, do you feel that the enlarged turning area provided adequate room for both the *COSCO Hamburg* and the *Delaware Bridge*?

*It can be done, but would benefit from larger area off Army Base*

- b. Based upon your simulation runs, do you feel that the enlarged turning area is necessary to bring the *COSCO Hamburg* and the *Delaware Bridge* to enter and leave the Reserve Channel?

*As mentioned above enlarging the proposed turning basin of the Army Base make it possible to negotiate the turn in and out, bow in and bow out or around another ship at dock*

- c. Should the enlarged turning area be modified? Feel free to sketch on Figure 3.

*Yes, see sketch*

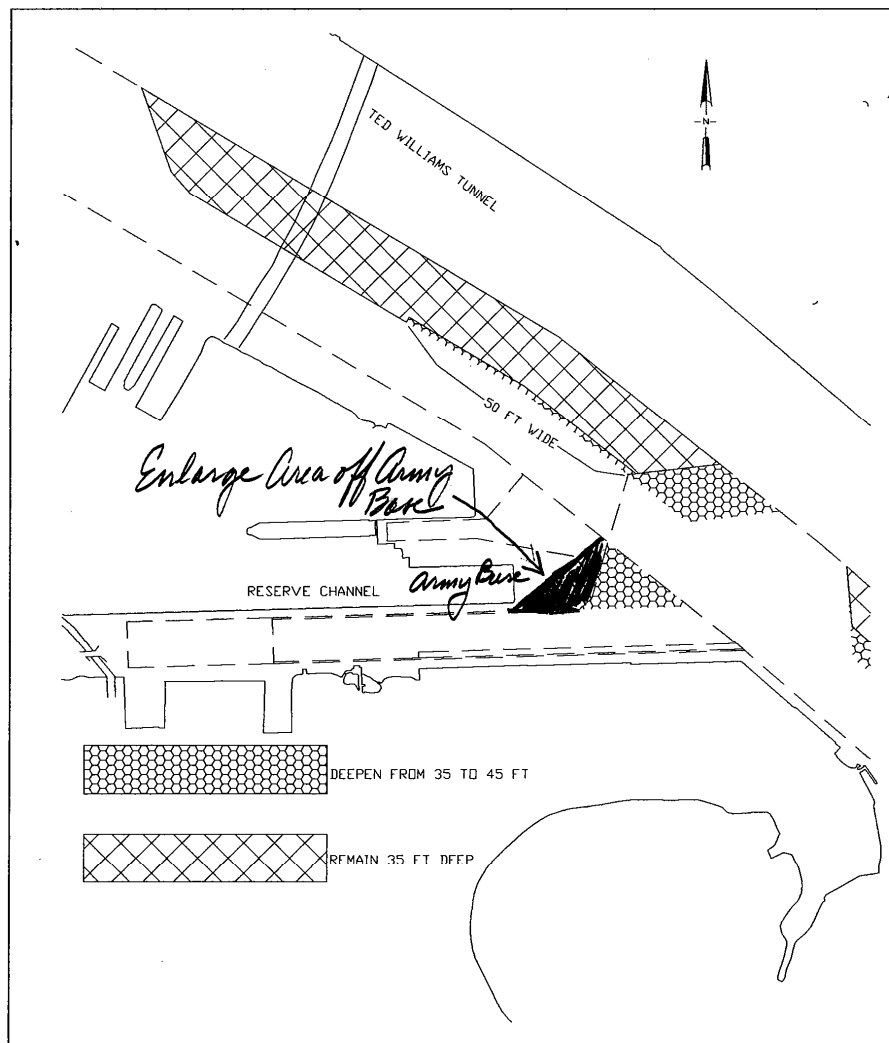


Figure 3. Widening near mouth of Reserve Channel

4. The following questions concern the simulation modeling of Boston Harbor.

a. Was the visual scene realistic, accurate, and adequate for the study?

*yes*

b. Do you feel the ships responded correctly to the currents?

*In most cases*

c. Do you feel the ships responded correctly to the bank forces?

*yes*

d. Do you feel the ships responded correctly to the wind?

*In most cases*

e. Any additional comments regarding the simulation model?

*Overall, I had a great experience.  
The staff administered the simulations  
in a competent professional manner.  
Thank You for your hard work on  
this project.*



Boston Harbor Channel Improvements  
Final Questionnaire

Captain Robert G. Cordes

Ships

The *COSCO Hamburg* - 918 - x 131 - x 46-ft containership.

The *Delaware Bridge* - 871.8 - 106 - x 43 ft containership.

1. A bend widener (Figure 1) is proposed for the East Part of the Boston North Channel. The purpose of the widener was to provide additional maneuvering room near Finns Ledge.

- a. Based upon your simulation runs, do you feel that the widener provided adequate room for both the *COSCO Hamburg* and the *Delaware Bridge*?

Yes

- b. Based upon your simulation runs, do you feel that the widener is necessary to bring the *COSCO Hamburg* and the *Delaware Bridge* into and out of Boston Harbor?

No, But It Gives You The Extra Room Needed In The Event You Meet Another Vessel At This Juncture. It Also Reduces The Degree Of Turn To Maintain Ability To Remain On Green Side Of Channel (Deep Side).

- c. Will the widener benefit other vessels calling at Boston Harbor? If so, which vessels and in what manner would they benefit.

Yes, LNG Tankers. It Allows For A Less Radical Turn To Port To Keep On Green (Deep) Side Of North Channel.

- d. Should the widener be modified? Feel free to sketch on Figure 1.

See sketch!

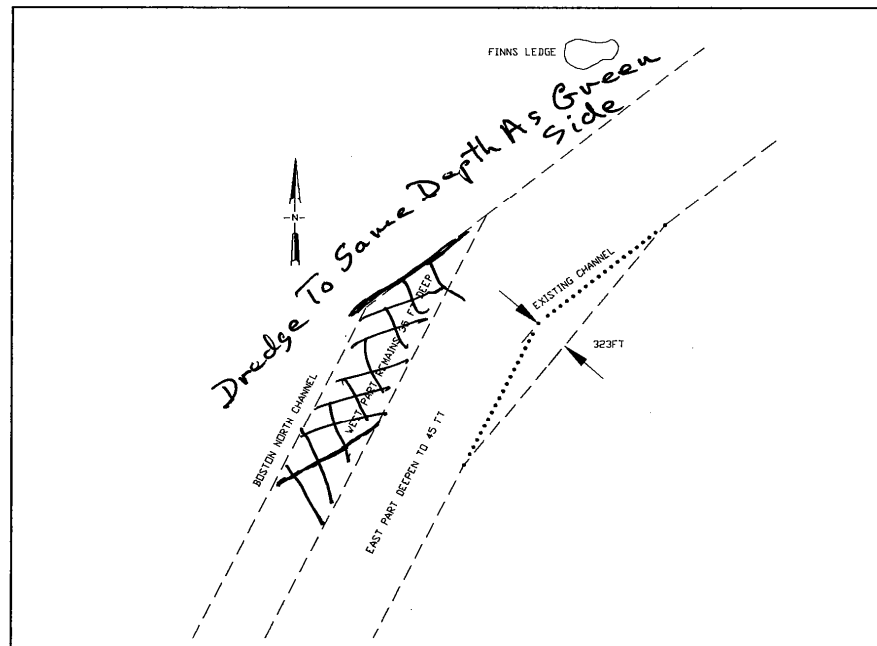


Figure 1. Boston North Channel Bend Widener

2. Widening of the deepened 45 ft channel near Spectacle Island is proposed. The widening will be accomplished by deepening on the south side of the 35 ft channel. The channel width would be increased to 800 feet with 880 feet through the turns. The widening is shown in Figure 2. The purpose of the additional width is permit passage of these larger vessels through this reach of the harbor's Main Ship Channel and to ease passage in the two turns above Spectacle Island.

- a. Based upon your simulation runs, do you feel that the additional width provided adequate room for both the *COSCO Hamburg* and the *Delaware Bridge*?

Yes

- b. Based upon your simulation runs, do you feel that the additional width is necessary to bring the *COSCO Hamburg* and the *Delaware Bridge* to make the turn near Spectacle Island?

Yes

- CA Will the widener benefit other vessels calling at Boston Harbor? If so, which vessels and in what manner would they benefit.

Yes, LNG Tankers, In Sudden High Wind Gusts, And would Also Allow For Larger LNG's. i.e. Longer & Wider

- d c. Should the channel width in the straight sections or in the two turns be modified? Feel free to sketch on Figure 2.

See Note on Sketch.

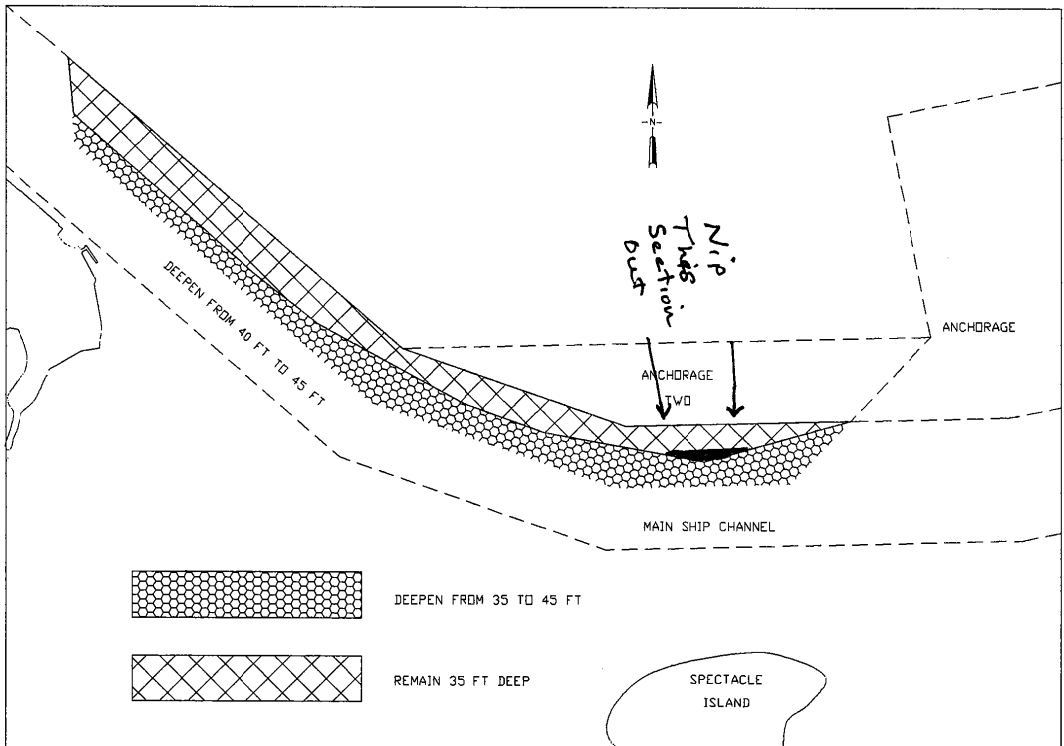


Figure 2. Spectacle Island Widening

3. Widening near the mouth of the Reserved Channel is proposed. The widening will increase the size of the turning area from a radius of 1200 feet to a radius of 1500 feet. and also provide 50 ft additional width for the 45 ft channel north of the turning area. The widening is shown in Figure 3. The turning area is being increased to allow larger containerships access to the Reserve Channel. The additional 50 ft width is to allow more maneuvering room for larger bulk carriers expected to call on the Massport marine Terminal just north of the Reserve Channel.

- a. Based upon your simulation runs, do you feel that the enlarged turning area provided adequate room for both the *COSCO Hamburg* and the *Delaware Bridge*?

Yes

- b. Based upon your simulation runs, do you feel that the enlarged turning area is necessary to bring the *COSCO Hamburg* and the *Delaware Bridge* to enter and leave the Reserve Channel?

Yes

- c. Should the enlarged turning area be modified? Feel free to sketch on Figure 3.

Yes (See Note on Sketch.)

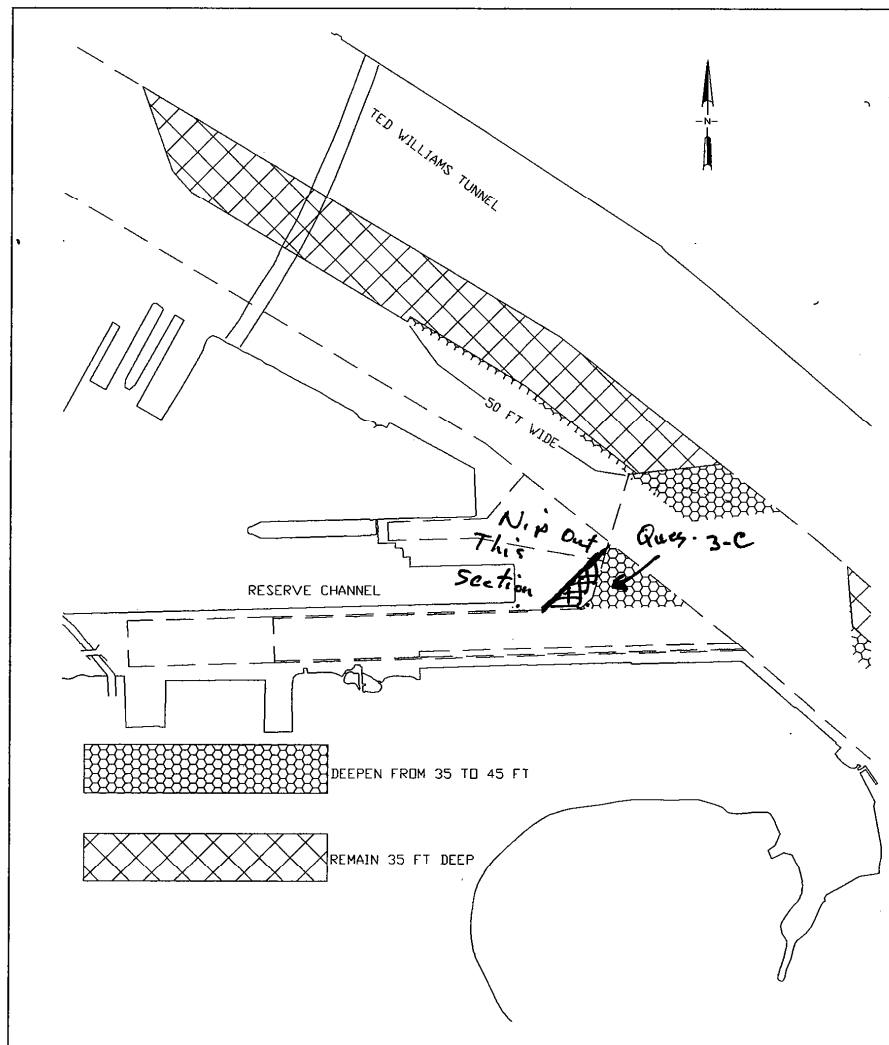


Figure 3. Widening near mouth of Reserve Channel

4. The following questions concern the simulation modeling of Boston Harbor.

a. Was the visual scene realistic, accurate, and adequate for the study?

Yes

b. Do you feel the ships responded correctly to the currents?

Yes

c. Do you feel the ships responded correctly to the bank forces?

Yes

d. Do you feel the ships responded correctly to the wind?

Yes

e. Any additional comments regarding the simulation model?

No, It Was Quite Satisfactory!

Boston Harbor Channel Improvements  
Final Questionnaire

Captain F. R. MORTON

Ships

The *COSCO Hamburg* - 918 - x 131 - x 46-ft containership.

The *Delaware Bridge* - 871.8 - 106 - x 43 ft containership.

1. A bend widener (Figure 1) is proposed for the East Part of the Boston North Channel. The purpose of the widener was to provide additional maneuvering room near Finns Ledge.

- a. Based upon your simulation runs, do you feel that the widener provided adequate room for both the *COSCO Hamburg* and the *Delaware Bridge*?

YES. THE  
ADDITIONAL ROOM WILL BE A BIG  
HELP WHEN SHIPS ARE MEETING.

- b. Based upon your simulation runs, do you feel that the widener is necessary to bring the *COSCO Hamburg* and the *Delaware Bridge* into and out of Boston Harbor?

YES.

- c. Will the widener benefit other vessels calling at Boston Harbor? If so, which vessels and in what manner would they benefit.

THE WIDENER WILL BENEFIT THE  
TRANSIT OF LNG TANKERS AND CRUISE  
SHIPS. THESE ARE BOTH GENERALLY BIG  
VESSELS THAT NEED LONGER TURNING AREAS.

- d. Should the widener be modified? Feel free to sketch on Figure 1.

NO. IT IS FINE AS PROPOSED.



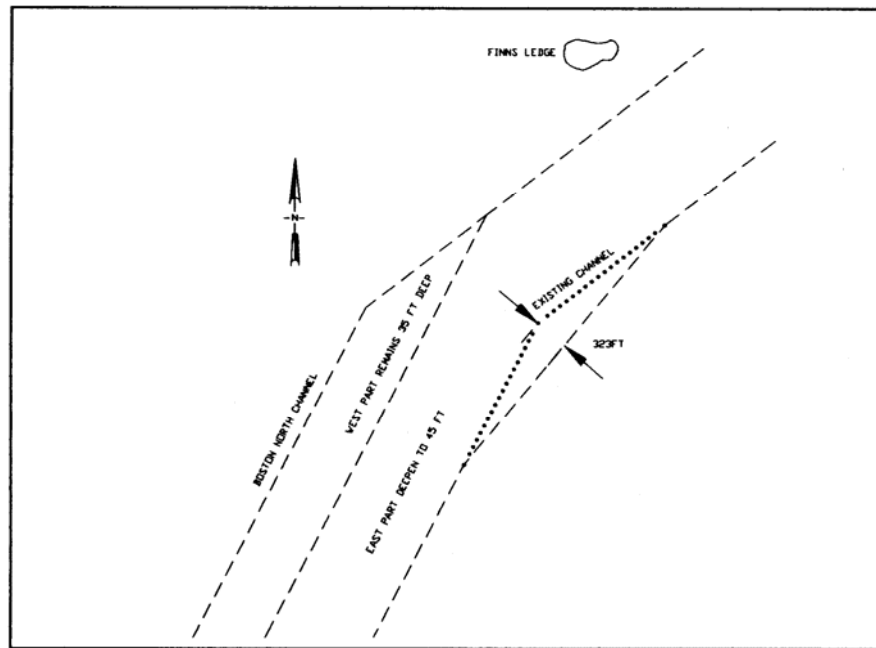


Figure 1. Boston North Channel Bend Widener

2. Widening of the deepened 45 ft channel near Spectacle Island is proposed. The widening will be accomplished by deepening on the south side of the 35 ft channel. The channel width would be increased to 800 feet with 880 feet through the turns. The widening is shown in Figure 2. The purpose of the additional width is permit passage of these larger vessels through this reach of the harbor's Main Ship Channel and to ease passage in the two turns above Spectacle Island.

- a. Based upon your simulation runs, do you feel that the additional width provided adequate room for both the *COSCO Hamburg* and the *Delaware Bridge*? *YES.*

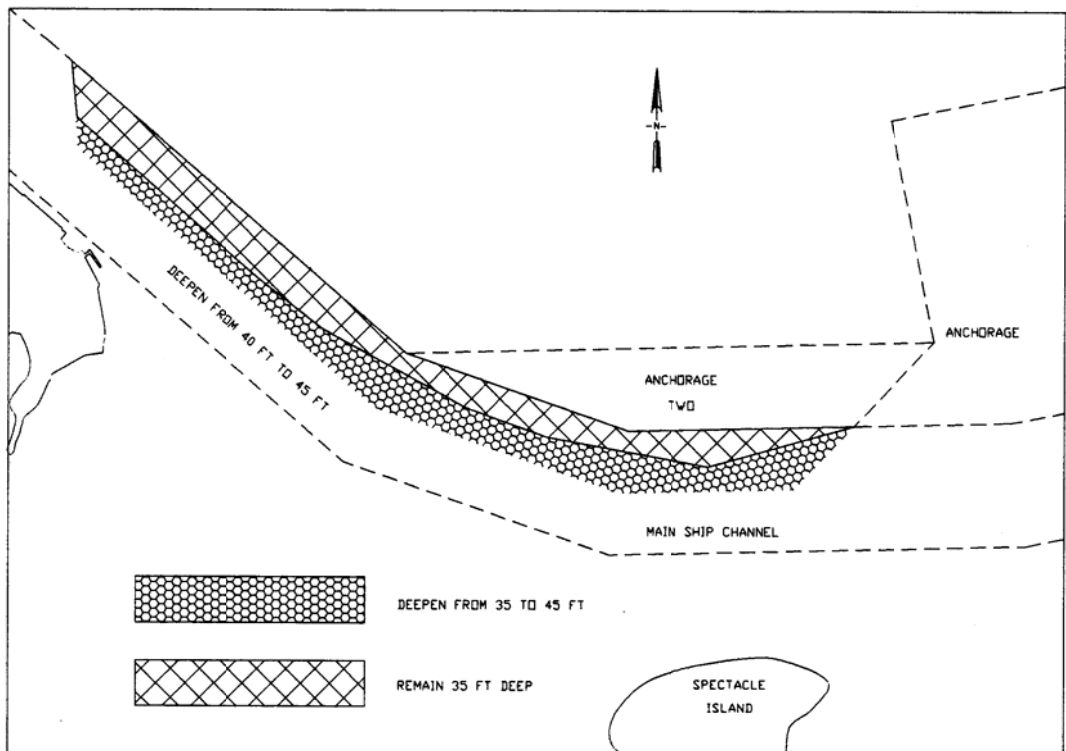
- b. Based upon your simulation runs, do you feel that the additional width is necessary to bring the *COSCO Hamburg* and the *Delaware Bridge* to make the turn near Spectacle Island? *YES*

- c. Will the widener benefit other vessels calling at Boston Harbor? If so, which vessels and in what manner would they benefit. *LNG TANKERS, CRUISE SHIPS, AIRCRAFT CARRIES, ALSO LOADED INBOUND TANKERS WITH A FLOOD TIDE WOULD ADDITIONAL ROOM TO MAKE TURNS.*

- c. Should the channel width in the straight sections or in the two turns be modified? Feel free to sketch on Figure 2.

*NO. IT IS WELL PLANNED AS IS.*

Figure 2. Spectacle Island Widening



3. Widening near the mouth of the Reserved Channel is proposed. The widening will increase the size of the turning area from a radius of 1200 feet to a radius of 1500 feet. and also provide 50 ft additional width for the 45 ft channel north of the turning area. The widening is shown in Figure 3. The turning area is being increased to allow larger containerships access to the Reserve Channel. The additional 50 ft width is to allow more maneuvering room for larger bulk carriers expected to call on the Massport marine Terminal just north of the Reserve Channel.

- a. Based upon your simulation runs, do you feel that the enlarged turning area provided adequate room for both the *COSCO Hamburg* and the *Delaware Bridge*?

YES.

- b. Based upon your simulation runs, do you feel that the enlarged turning area is necessary to bring the *COSCO Hamburg* and the *Delaware Bridge* to enter and leave the Reserve Channel?

YES

- c. Should the enlarged turning area be modified? Feel free to sketch on Figure 3.

YES. I PREFER THE ALTERNATIVE TURNING NOTCH AS SHOWN IN FIGURE 4. THIS PROVIDED FOR AN EASIER TURN AROUND BOTH INBOUND AND OUTBOUND. IT ALSO KEEPS THE SHIPS AWAY FROM THE AIRPORT RUNWAY.

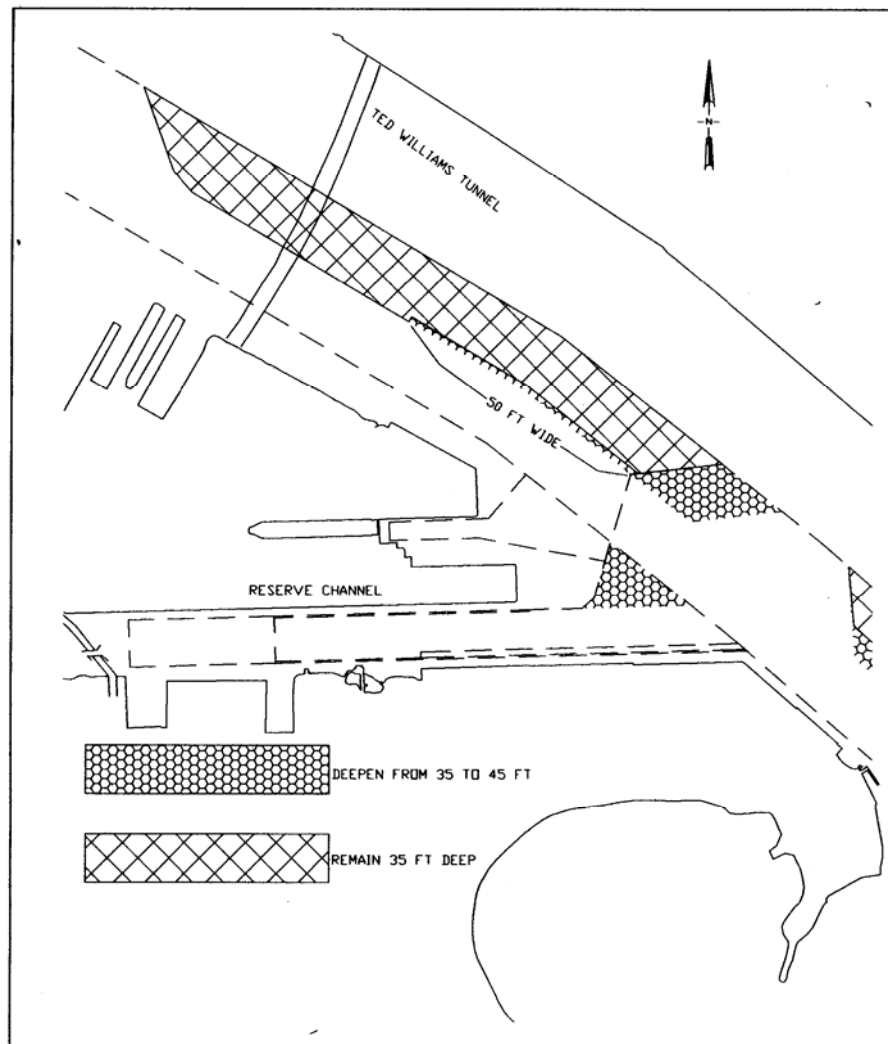


Figure 3. Widening near mouth of Reserve Channel

4. An alternative turning notch was simulated during the final days of the second week of simulations. It is shown in Figure 4.

- a. Based upon your simulation runs, do you feel that the enlarged turning area provided adequate room for both the *COSCO Hamburg* and the *Delaware Bridge*?

YES.

- b. Based upon your simulation runs, do you feel that the enlarged turning area is necessary to bring the *COSCO Hamburg* and the *Delaware Bridge* to enter and leave the Reserve Channel?

YES.

- c. Should the enlarged turning area be modified? Feel free to sketch on Figure 4.

NO. I PREFER THIS TURNING AREA  
OVER THE OTHER PROPOSAL. IT MAKES  
FOR MUCH EASIER TURNS.

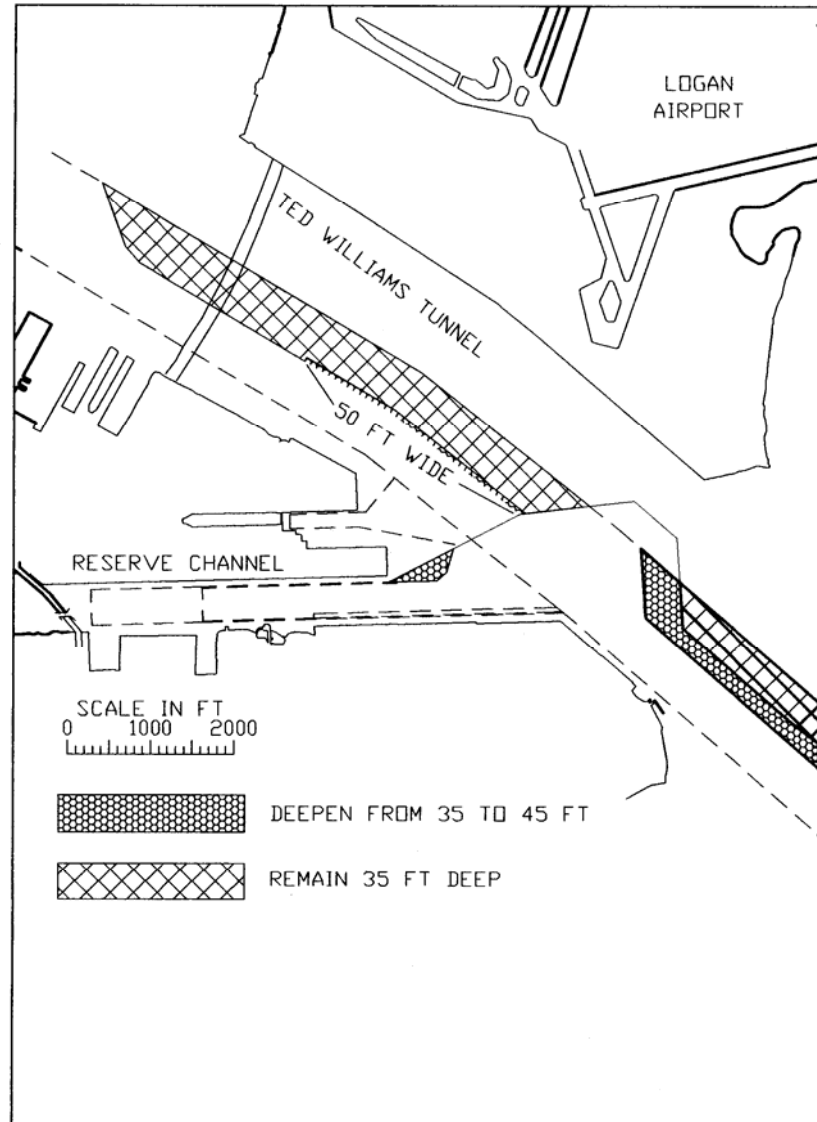


Figure 4. Plan 2 turning notch

5. The following questions concern the simulation modeling of Boston Harbor.

- a. Was the visual scene realistic, accurate, and adequate for the study?

YES, VERY MUCH SO.

- b. Do you feel the ships responded correctly to the currents?

YES ON THE FLOOD CURRENT. BUT NOT ON THE EBB. THE EBB CURRENT REALLY SHOWS THE SHIPS DOWN IN THE MAIN CHANNEL OF CONLEY TERMINAL.

- c. Do you feel the ships responded correctly to the bank forces?

YES.

- d. Do you feel the ships responded correctly to the wind?

YES

- e. Any additional comments regarding the simulation model?

VERY GOOD SIMULATOR. I ENJOYED WORKING ON IT AND LEARNED A LOT. AN EXCELLENT STAFF TO WORK WITH.



Boston Harbor Channel Improvements  
Final Questionnaire

Captain MIKE PEDDLE

Ships

The *COSCO Hamburg* - 918 - x 131 - x 46-ft containership.

The *Delaware Bridge* - 871.8 - 106 - x 43 ft containership.

1. A bend widener (Figure 1) is proposed for the East Part of the Boston North Channel. The purpose of the widener was to provide additional maneuvering room near Finns Ledge.

- a. Based upon your simulation runs, do you feel that the widener provided adequate room for both the *COSCO Hamburg* and the *Delaware Bridge*? **YES. LONGER VESSELS WOULD HAVE NO DIFFICULTY MAKING THAT TURN. TWO WAY TRAFFIC AT CHANNEL ENTRANCE WOULD BE POSSIBLE**
- b. Based upon your simulation runs, do you feel that the widener is necessary to bring the *COSCO Hamburg* and the *Delaware Bridge* into and out of Boston Harbor? **WITH THE DRAFT ~~4~~ U.K.C. OF THE COSCO HAMBURG, THE WIDENER PROVIDES A GREATER MARGIN OF SAFETY IN ADVERSE CONDITIONS.**
- c. Will the widener benefit other vessels calling at Boston Harbor? If so, which vessels and in what manner would they benefit. **TWO WAY PASSING OR OVERTAKING ~~WOW~~ COULD BE DONE SAFELY WITH 99% OF VESSELS CALLING. CURRENTLY ONLY ONE WAY PASSAGE AT FINN'S.**
- d. Should the widener be modified? Feel free to sketch on Figure 1. **DON'T SEE NEED TO EXPAND CURRENT PROPOSAL.**

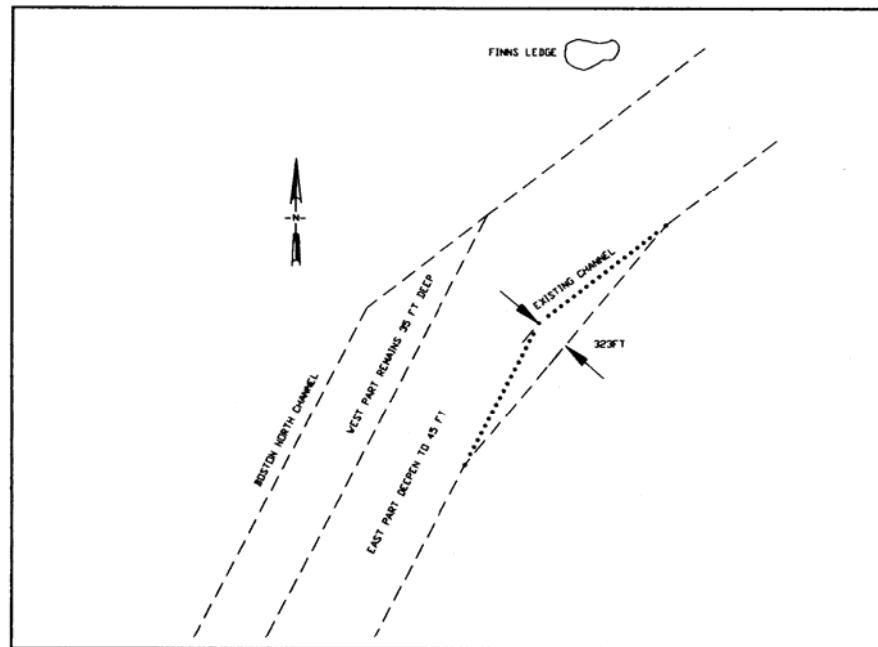


Figure 1. Boston North Channel Bend Widener

2. Widening of the deepened 45 ft channel near Spectacle Island is proposed. The widening will be accomplished by deepening on the south side of the 35 ft channel. The channel width would be increased to 800 feet with 880 feet through the turns. The widening is shown in Figure 2. The purpose of the additional width is permit passage of these larger vessels through this reach of the harbor's Main Ship Channel and to ease passage in the two turns above Spectacle Island.

- a. Based upon your simulation runs, do you feel that the additional width provided adequate room for both the *COSCO Hamburg* and the *Delaware Bridge*?

DEFINITELY

- b. Based upon your simulation runs, do you feel that the additional width is necessary to bring the *COSCO Hamburg* and the *Delaware Bridge* to make the turn near Spectacle Island?

YES

- c. Will the widener benefit other vessels calling at Boston Harbor? If so, which vessels and in what manner would they benefit.

TANKER (DEEP DRAFT), BULKER'S (SALT + SCRAP).  
WOULD BE RESTRICTED ONLY BY DEPTH AT BERTH NOT  
CHANNEL DEPTH.

- c. Should the channel width in the straight sections or in the two turns be modified? Feel free to sketch on Figure 2.

PROPOSAL WORKED FINE.  
CHANGES/MODIFICATIONS WOULD BE NIT PICKING.

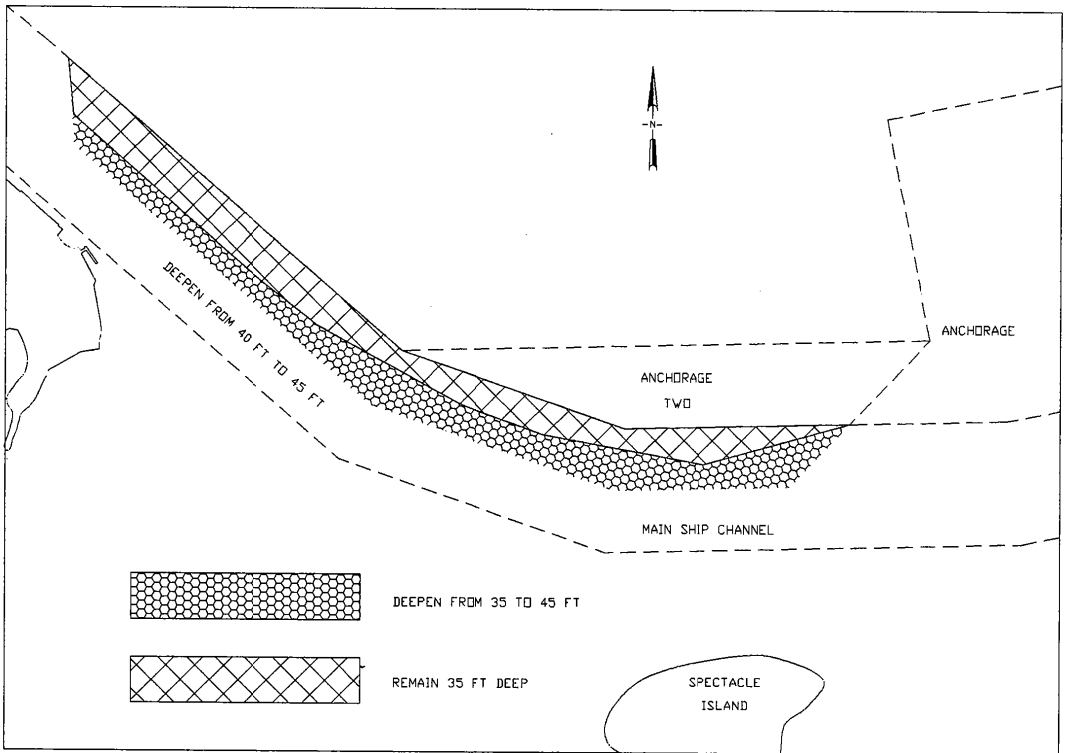


Figure 2. Spectacle Island Widening

3. Widening near the mouth of the Reserved Channel is proposed. The widening will increase the size of the turning area from a radius of 1200 feet to a radius of 1500 feet. and also provide 50 ft additional width for the 45 ft channel north of the turning area. The widening is shown in Figure 3. The turning area is being increased to allow larger containerships access to the Reserve Channel. The additional 50 ft width is to allow more maneuvering room for larger bulk carriers expected to call on the Massport marine Terminal just north of the Reserve Channel.

- a. Based upon your simulation runs, do you feel that the enlarged turning area provided adequate room for both the *COSCO Hamburg* and the *Delaware Bridge*?

DEFINITELY

- b. Based upon your simulation runs, do you feel that the enlarged turning area is necessary to bring the *COSCO Hamburg* and the *Delaware Bridge* to enter and leave the Reserve Channel?

YES

- c. Should the enlarged turning area be modified? Feel free to sketch on Figure 3.

SEE PROPOSAL <sup>1</sup> 2

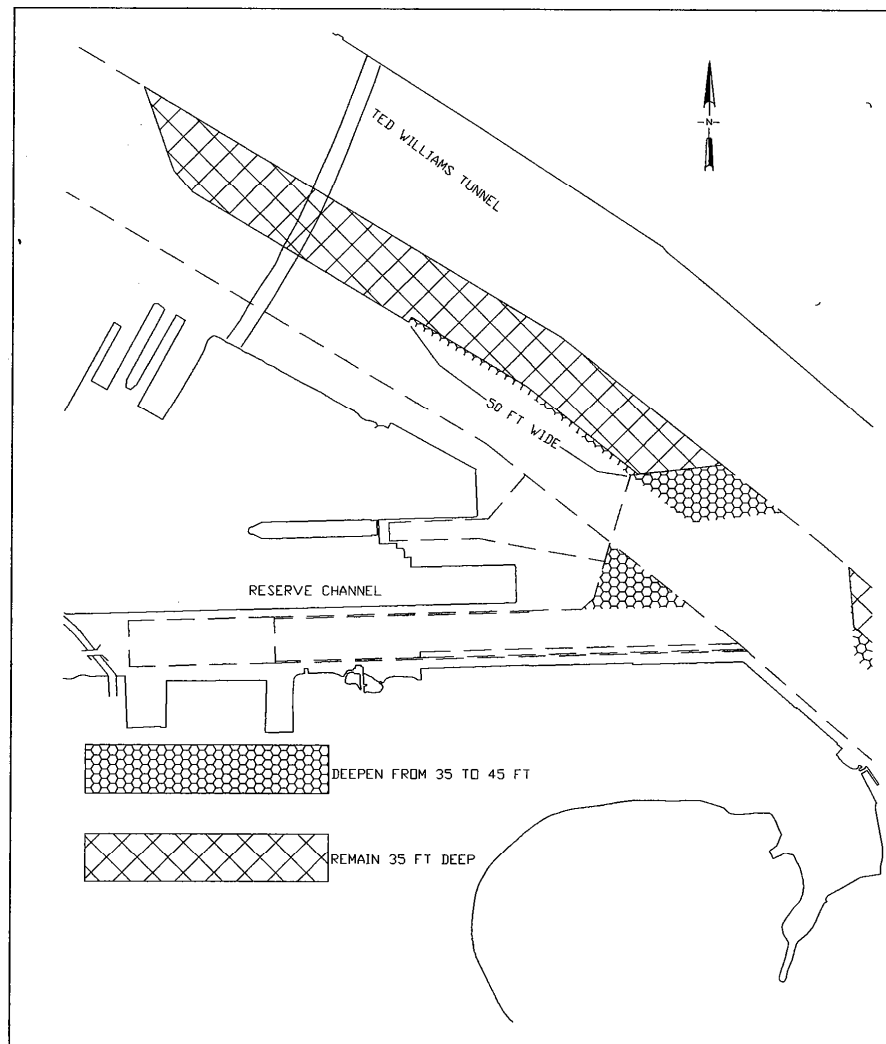


Figure 3. Widening near mouth of Reserve Channel

4. An alternative turning notch was simulated during the final days of the second week of simulations. It is shown in Figure 4.

- a. Based upon your simulation runs, do you feel that the enlarged turning area provided adequate room for both the *COSCO Hamburg* and the *Delaware Bridge*?

YES

- b. Based upon your simulation runs, do you feel that the enlarged turning area is necessary to bring the *COSCO Hamburg* and the *Delaware Bridge* to enter and leave the Reserve Channel?

IF INTENT IS TO MINIMIZE IMPACT TO AIR TRAFFIC,  
THE ALTERNATIVE NOTCH WORKED WELL.

- c. Should the enlarged turning area be modified? Feel free to sketch on Figure 4.

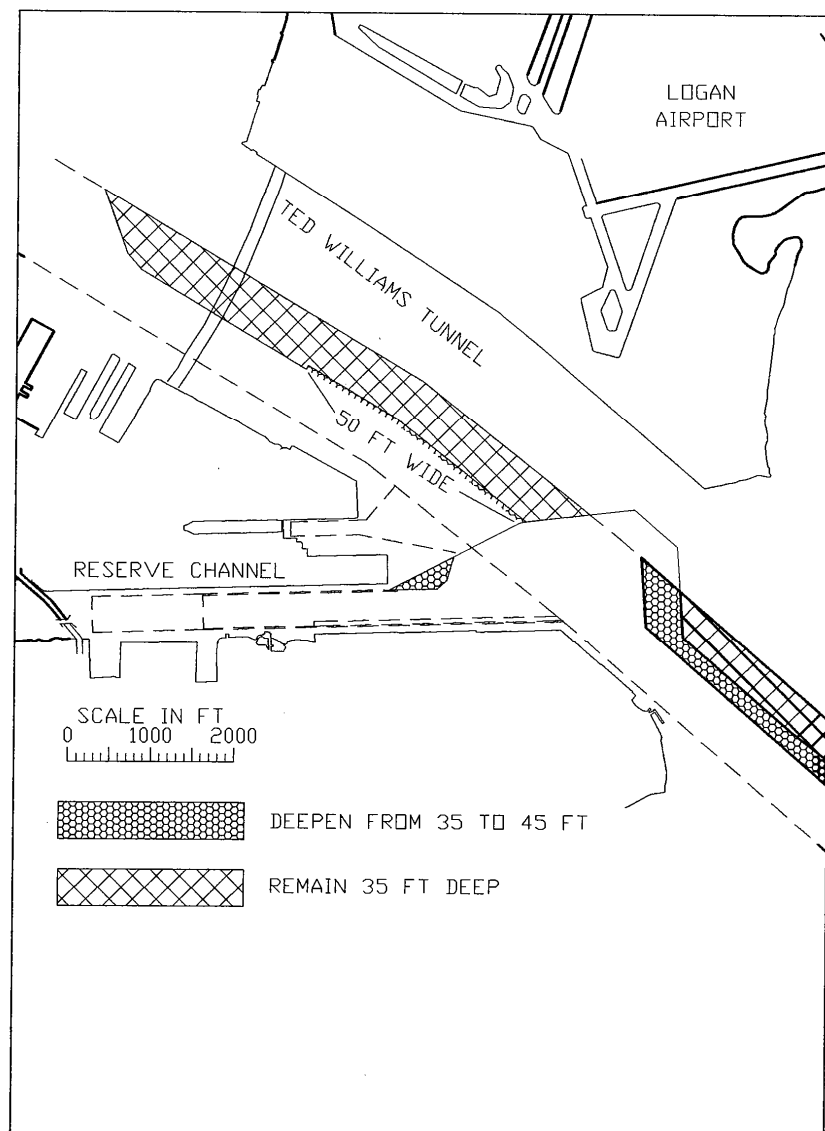


Figure 4. Plan 2 turning notch



5. The following questions concern the simulation modeling of Boston Harbor.

a. Was the visual scene realistic, accurate, and adequate for the study?

YES

b. Do you feel the ships responded correctly to the currents?

YES

c. Do you feel the ships responded correctly to the bank forces?

AS MODELED, THE PROGRAM RESPONDED AS DESIGNED.  
HOWEVER, SUCTION OCCURED WHERE IT NORMALLY WOULDN'T.

d. Do you feel the ships responded correctly to the wind?

GENERALLY, YES

e. Any additional comments regarding the simulation model?

TUGS SEEMED A LITTLE WEAKER THAN EXPECTED

<b>REPORT DOCUMENTATION PAGE</b>				<i>Form Approved</i> <b>OMB No. 0704-0188</b>	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. <b>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</b>					
<b>1. REPORT DATE (DD-MM-YYYY)</b> August 2006		<b>2. REPORT TYPE</b> Final report		<b>3. DATES COVERED (From - To)</b>	
<b>4. TITLE AND SUBTITLE</b>  Boston Harbor, Massachusetts, Deep-Draft Navigation Improvement Project Feasibility Study; Channel Improvement Investigations				<b>5a. CONTRACT NUMBER</b>	
				<b>5b. GRANT NUMBER</b>	
				<b>5c. PROGRAM ELEMENT NUMBER</b>	
<b>6. AUTHOR(S)</b> Dennis W. Webb and Mark L. Habel				<b>5d. PROJECT NUMBER</b>	
				<b>5e. TASK NUMBER</b>	
				<b>5f. WORK UNIT NUMBER</b>	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b>  Coastal and Hydraulics Laboratory, U.S. Army Engineer Research and Development Center, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199; U.S. Army Engineer District, New England, 696 Virginia Road Concord, MA 01742-2751				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>  ERDC/CHL TR-06-11	
<b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b> U.S. Army Engineer District, New England 696 Virginia Road Concord, MS 01742-2751				<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>	
				<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b>	
<b>12. DISTRIBUTION / AVAILABILITY STATEMENT</b> Approved for public release; distribution is unlimited.					
<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT</b> Boston Harbor is located on the eastern shore of the Commonwealth of Massachusetts, on Massachusetts Bay. The Corps of Engineers and the Massachusetts Port Authority (Massport) are evaluating a number of improvements to Boston Harbor. These improvements include deepening and widening portions of the Broad Sound North Entrance Channel, Main Ship Channel, and lower Reserved Channel and its turning area for the benefit of larger container vessels calling on Massport's Conley Terminal. To assist in evaluating these improvements, the U.S. Army Engineer Research and Development Center (ERDC) conducted a ship-simulator-based navigation study. Data for the simulation models were obtained during a site visit to ride ships in the project area. Currents for both the existing and proposed channels were calculated using the ADCIRC computer model in a joint effort between ERDC and the U.S. Army Engineer District, New England. Harbor pilots traveled from Boston to validate and operate the simulations in September 2005.					
<b>15. SUBJECT TERMS</b> Boston Harbor simulation Navigation Reserved Channel					
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>	<b>18. NUMBER OF PAGES</b>  98	<b>19a. NAME OF RESPONSIBLE PERSON</b>
<b>a. REPORT</b>  Unclassified	<b>b. ABSTRACT</b>  Unclassified	<b>c. THIS PAGE</b>  Unclassified			<b>19b. TELEPHONE NUMBER</b> (include area code)